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TREATISE

ON THE

DISEASES OF THE EAR,

INCLUDING THE

ANATOMY OF THE ORGAN,

BY

ANTON VON TRÖLTSCH, M. D.,
PROFESSOR IN THE UNIVERSITY OF WÜRZBURG, BAVARIA.

TRANSLATED AND EDITED

BY

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THIS TRANSLATION

IS

Respectfully Dedicated

TO

ALFRED C. POST, M. D.,

PROFESSOR OF SURGERY IN THE UNIVERSITY OF THE CITY OF NEW YORK, CONSULTING SURGEON TO THE NEW YORK AND ST. LUKE'S HOSPITALS,

WHO, BESIDES HIS USEFUL LABORS IN THE FIELD OF GENERAL MEDICINE, HAS ACCOMPLISHED MUCH FOR AURAL SURGERY, AND TO WHOSE QUALITIES AS A TEACHER, SURGEON, AND A MAN, THIS GRATEFUL TESTIMONY IS BORNE

BY HIS

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TRANSLATOR'S PREFACE.

THIS work has been out of print for some time, but circumstances beyond the control of the editor, have prevented the earlier publication of the present edition.

Although this volume is nominally a revised edition of the former one, it is in fact a new work. It is translated from the fourth German edition, to which the author has made large additions. The original has also been greatly improved by a thorough revision, and in many parts it has been entirely rewritten.

The editor has also added numerous illustrative cases, both from his own practice and that of others. Many new engravings, and a copious index, have been added. In some rare instances, where the experience of the editor has led him to form different opinions from those entertained by the author, he has not failed — with modesty it is hoped — to express them.

The additions made by the editor will be found enclosed in parentheses, and further indicated by the initials, St. J. R. It will be observed that these additions and changes by the author and editor have doubled the number of pages in the volume.

The science of Otology is fast taking its place in the van of the great movement in the ranks of Medicine. Diseases of the Ear are now receiving that attention which humanity has vainly demanded of our profession for centuries. Congratulating his readers upon this new epoch in medical science, the editor hopes that this translation of the work of one of the leaders in this onward movement, may be found to be an acceptable text-book for those who wish to study the diseases of the organ of hearing, and that it may receive the same hearty reception that was given its immediate predecessor.

The editor has been assisted in the preparation of the translation of the lectures on the anatomy of the ear, by his friends Dr. RIDER, of Rochester, N. Y., and Dr. KIPP, of Newark, N. J. He desires also to present his acknowledgments to Dr. BEARD, of this city, for valuable assistance in the preparation of the work for the press.

151 Lexington Avenue, New York,
December, 1868.

AUTHOR'S PREFACE

TO THE FIRST EDITION.

I SCARCELY need to apologize to my professional brethren for the attempt here made to present a text-book which should embrace the whole field of aural medicine and surgery, and be chiefly founded upon my own observations and investigations. If I require any justification for this endeavor, it may be found in the dissevered position which Otology still holds, both in science and practice, as well as in the rarity of strictly scientific and independent labors in this field.

I chose the form of academical lectures, as the one in which my thoughts should be expressed, because it seemed to me that a certain brevity of expression, as well as a reiteration of firmly established truths, rather than a full consideration of subjects still under discussion, and consequently unsettled, would increase the value of a work intended for the practitioner.

By thus doing, I have been enabled to cut short all historical considerations, and critical estimations of what has been accomplished, much more than would have been allowable in another kind of a text-book. I believe my readers will thank me for the latter, especially.

All detailed anatomical descriptions are also omitted. They may be found in my work on the anatomy of the Ear[1] (Würzburg, 1860), to which I beg leave to refer my readers in all anatomical questions. I have been at times obliged to repeat myself, lest there should be a want of clearness in some of the statements. I also hope that no one will deem it any objection to my work, that I have freely, and even literally, in some places, incorporated in this work the results of my previous investigations on some subjects, for instance, on the examination and diseases of the external ear, catheterization, and perforation of the mastoid process.

One of our most intellectual thinkers, the æsthetical *Vischer*, has said, that the road to knowledge

view of the center, and finally, in our advance, we may penetrate it from several points.

The profound wisdom of this declaration, is perhaps nowhere more plainly shown than in investigations in the province of natural science. In such investigations a true enthusiasm for the subject will much more frequently express itself in those painstaking and plodding labors, peculiar to the Germanic race above all others, than in any free flights of fancy which would fill up deficiencies in knowledge, or combine facts together in such a way as to give a satisfactory and pleasing retrospect of what has been achieved.

If such a patient and slow, strictly methodical labor, proceeding under constant self-criticism from the periphery towards the center, is anywhere demanded, it is in the science of Otology, for the building up of which, fit material is yet to be procured, and solid foundations are still to be laid.

Here, each new, well chiselled, solid stone is of great and enduring worth, for, from these is to be obtained an increasingly stable foundation for a structure which shall gradually grow inhabitable.

It is certainly easier and quicker to rear a wooden edifice, which with gorgeous adorning may dazzle the eye, and whose color and ornaments may for a time beguile the ignorant into the belief that it is of stone, but time always exercises a just criticism, and

ere long such a worthless structure will be exposed to every gaze, in its real hollowness, while it falls emptily to pieces.

If I have anywhere formed wrong conceptions of facts, or explained them incorrectly, I shall be thankful for the proper information, and will gladly avail myself of any better knowledge.

I hope I may succeed in winning additional co-laborers in the field of Aural Surgery, since it is an equally grateful field, both in a practical and scientific point of view. I trust, also, that I have contributed towards obtaining for this specialty the esteem which is its due.

WÜRZBURG, May, 1862.

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Diseases and Anatomy of the Ear.

Treatise on Diseases of the Ear.

LECTURE I.

INTRODUCTION.

The great importance of diseases of the ear, as affecting the individual, his position in life, longevity and intellectual development; their very great frequency; the scientific position of aural medicine and surgery.

GENTLEMEN: There is scarcely any department of the science of medicine in which there is, even at this day, so much ignorance of facts, and such a want of positiveness of opinion, as in aural medicine and surgery. I therefore consider it to be my duty, before we begin any closer consideration of the subject of these lectures, to make a few remarks on the importance of aural diseases in general, as well as, upon the scientific position of aural medicine and surgery.

Diseases of the ear are among the most serious and frequent affections to which the human system is exposed. This statement is quite the contrary to what is generally heard and read on this subject, and it is probably quite the contrary of what you have heard and thought on the same subject. But in spite of this, my statement is the correct one, as I hope in a short time to be able to demonstrate to you. Let us, however, enter at once upon our theme.

In the first place let us speak of deafness. This is by far the most frequent of the consequences of aural affections. No one certainly will deny that every high degree of im-

pairment of hearing, is a very serious affection to the person concerned, in all his relations; because it limits very much his intercourse with others, and when it increases to a great extent it may entirely destroy his capability for business and social intercourse. Deafness also impairs the noblest of our functions, our capability for life among others. But it is not only the unrestricted enjoyment of life, which is thus greatly impaired by deafness, but many persons are affected in their vocation, in the exercise of their calling, and in their capability of securing a livelihood, by a loss of their hearing. Imagine for a moment that one of you becomes deaf; in what a position you are placed, as soon as you are obliged to confess that you are no longer capable of answering the requirements which your every day practice makes of the acuteness of your senses. Teachers, military officers and public officials are also, not unfrequently compelled to give up their position on account of impairment of hearing.

Not less important is the influence which impairment of hearing exerts upon the intellectual development of a child. If man be a creature of circumstances, the reciprocal relation should be considered, which exists between the acuteness of the senses, and clearness of thought. *Nil in intellectu quod non prius fuerit in sensu*, says Aristotle. The beginning and basis of all knowledge is the sense of experience. The impression of external objects, as they are carried by the senses to the brain, furnishes to the intellect the materials for the formation of ideas. In proportion as the impressions which the outer world makes upon the sensorium are sharp and clear, that is, the more acute our senses are, so much the more plainly and certainly will our views and ideas express themselves. If, on the contrary, the sensitive perceptions of a person are not clear, if they are partial and undecided, his whole nature and character l bear the same stamp of incompleteness and uncertainty.

By what way, we may ask, is the material for the intellectual development of the child conveyed to him? Undoubtedly through the ear. On this account, impairment of hearing occurring in early life, acquires a more or less permanent influence upon the formation and development of the intellectual nature, according as education and care resist these evil influences. Such children are not only unable, except with great difficulty, to concentrate their attention, but they are apt to remain inattentive and fickle, while the want of an acute perception, which is chiefly attained through the ear, renders a closely connected train of thought and a comprehensive grasping of intellectual and sensuous perceptions very difficult. People who from early life have been somewhat hard of hearing, have generally something in their nature a little foggy, are uncertain and weak in business, illogical and superfluous in thought and speech, abrupt and out of character in their answers. Hence, an experienced and attentive physician is not unfrequently able to decide, from the speech and bearing of a patient, after a short conversation, that he has probably not heard well since early childhood.

All this is true of a moderate amount of impairment of hearing. If it be of high degree, the child who does not hear speech does not learn to speak at all, or, if older, he forgets the sound of the words, and in either case becomes completely dumb as well as deaf. I do not need to tell you that a deaf and dumb person, even under the best method of instruction, can never be made an equal, useful member of society.

But in another respect affections of the ear are among those which make themselves felt in an extremely unpleasant manner. I have only to remind you of the subjective sounds in the ear, *tinnitus aurium*, in its various forms, which to many patients is much more troublesome than the impairment of hearing. This makes such an impres-

sion upon some patients, it is so confusing and disturbing to the senses, that its subjects are brought to a condition bordering on insanity.

I may also remind you of the fearful pain connected with many inflammations of the ear, and which often cause the most stolid and enduring men to shriek with agony. Added to all this, affections of the ear, especially those attended by suppuration, not unfrequently end in death. From neglected and long existing affections of the ear, cerebral abscesses, purulent meingitis, or pyæmia, are quite often developed, as each one of you has had occasion to see in the medical clinic.

Thus we see that diseases of the ear arrange themselves among those classes of affections which exert the deepest and most destructive influence; and that this influence extends even to the intellectual development, and upon the duration of life of the individual. Certainly they have a greater influence in these respects than diseases of the eye. It cannot be their harmlessness, then, which causes physicians to neglect them.

Diseases of the ear are besides very common. Most physicians believe that it is hardly worth the trouble to interest themselves in them because they are so rarely called upon for their treatment. But this is a very great error. There is an astonishingly large number of ear patients; and when we examine the matter a little more exactly, perhaps there are more ear than eye patients. I only need to remind you how frequently the ear is affected in a certain class of constitutional affections. This is almost regularly the case in measles, scarlet fever and small pox; and it is very frequently affected in typhus fever, in tuberculosis, and whooping cough, whilst some very common and every day diseases, such as nasal and pharyngeal catarrh, almost always affect the ear. Remember, moreover, that nearly all who have passed the age of fifty

or sixty years no longer hear well; a fact to which we are so accustomed that we are inclined to consider it as a physiological condition. Consider further that in childhood purulent discharges from the ear are not uncommon, whilst earache is so frequent that nearly all children suffer more or less from it. In middle age, also, diseases of the ear are still frequent; and a great proportion of individuals at this age will show, by accurate examination, a diminution in the acuteness of hearing, either on both sides or one side only. Many of your acquaintances can auscultate with the one ear only—"from habit," they perhaps believe, but in truth because the hearing in the other ear has become impaired, although they may not be conscious of the fact. The ordinary duties of life not requiring perfectly acute hearing, it must become considerably impaired in order to interfere with our social intercourse. Deafness on one side only, is especially apt to escape the notice not only of others, but also of the patient himself.

Although it is difficult to make a definite estimate of the proportion of individuals whose hearing is more or less impaired, still I believe I shall make too small rather than too large an estimate, when I assert that not more than one out of three persons of from twenty to forty years of age still possesses good and normal hearing. You will notice this fact in your practice. At first you will hear but little of ear diseases, until, by some fortunate accident, the people learn that an aurist lives among them. Then suddenly a great number of patients will appear, and many of them will be of your acquaintances, and persons whom you had not suspected as suffering from diseases of the ear.

Diseases of the eye are not easily concealed, whilst diseases of the ear very frequently escape our notice, either with or without the connivance of the patient. Believe

me, the number of ear patients is enormously great, and this number will apparently still further increase when there are more surgeons to recognize and treat them; for hitherto these diseases have been either unnoticed at their beginning, or intentionally concealed. The fact that physicians have so far troubled themselves so little about ear diseases cannot therefore depend upon a want of material.

Since, therefore, the diseases of the ear are so frequent and their results so important, influencing, as they do, the happiness of the individual, his social position, his mental development, and even endangering his life, what would be more reasonable than to suppose that the attention of physicians would have been directed in a corresponding manner to their treatment? You know, however, very well, that this department of medicine has been neglected, and that the development of aural surgery has not kept pace with the other departments of medical science. Whilst other parts of medicine were emerging from the mists of philosophical speculation into the domain of sober facts, derived from observations upon the living subject and the cadaver, which alone can form a safe foundation for therapeutics, a considerable time elapsed before aural surgery chose this safe and certain stand-point. In Germany, especially—and this we confess to our shame—there ruled an obstinate, intolerant dogmatism, which completely neglected investigations on the cadaver, and made observations on the living subject in a very superficial and careless manner only. The physicians who busied themselves with this branch of medicine were very few, and the universities quite ignored it. Hence even accomplished physicians knew but little about ear diseases; and it was but natural that aural surgery should remain far behind the other departments of medicine, which had able representatives in the universities, and abundant development among the profession in general.

It gradually became the custom, however, to ascribe the want of practical results and scientific progress to the nature of the subject itself, and to deny that there was any capability of development and accomplishment in the study of diseases of the ear. The cases of aural disease were dismissed with the assertion, that there was nothing to be done for them. Now add to all this, the fact, that among those who especially cultivated this field of science, incessant literary contention occurred. One of these disputants was noted for his arrogance, another for his sordid manner of treating the whole subject, while a third published the most frivolous hypotheses. You will easily understand how physicians placed little confidence in researches and labors, exhibiting so little that was really valuable and so much that was disagreeable. At last, everything that merely reminded the profession of aural disease was received with antagonism, or jeering mirth. So that so late as 1856, it was openly declared to your lecturer, that one who became an aural surgeon, would put his good name in jeopardy.

In order that diseases of the ear may receive the attention that their importance demands, aural medicine and surgery must endeavor to elevate itself, in a scientific and ethical point of view. A very great influence for the scientific reformation of this department proceeded from Great Britain.

Wilde of Dublin and *Toynbee* of London (the former is still living, the latter died in July, 1866), contributed most to this change; the former by his very careful clinical observations of the course of the diseases of the ear, and of the objective appearances especially, of the membrana tympani; the latter by his numerous sections of the auditory apparatus, as well as by various contributions to our anatomical and physiological knowledge of aural disease.

The critical German spirit immediately recognized cer-

tain one sided views in the diagnosis and treatment of aural disease, such as are even yet prevalent in England, and very soon there arose among us a zealous desire for a wider and independent building up of this science. From year to year the number of physicians increased, who took up the study of aural disease with interest, and who had a proper understanding of the subject. In one medical school after another teachers arose, who prepared the way for progress in a fundamental knowledge of this specialty. Hand in hand with this there was a very great increase in the force engaged in teaching and practising in this department—a field only a short time before uncultivated—and a new life was begun.

The results of former observation were reëxamined in the light of new anatomical and physiological ideas, furnished by modern methods of examination and treatment; and thus, a large and varied experience was acquired which furnished the unprejudiced observer with a great number of new points of observation and altered views.

Corresponding to this undeniably great scientific progress in all directions, which to a great extent was made practically available, the interest of the profession at large in the affections of the organ of hearing also increased. Where there was formerly slight estimation and derision, we now find a ready recognition of what has been accomplished, a proper estimation of the subject, and abundant belief in the future. In the same way, the laity not less than the profession, gradually begin to give to diseases of the ear the consideration that their serious character demands. It is only a dull or short sighted observer that will now deny that this whole matter has very recently changed its position in all respects.

It is true, however, that very much remains yet to be done and to be desired. We as yet have seen only the proper beginning. It must be considered a very considerable progress that the gaps and deficiencies in our

knowledge are now more clearly and distinctly seen; that the ends to be yet attained are more decided, and the way for future progress is opened up in many directions.

We now require more precision in the diagnosis and treatment of morbid conditions of the outer and middle ear, and our ideas as to independent and secondary processes in the nervous part of the ear, must have a firmer footing. It will be one of the most important tasks of the coming time to furnish diagnostic appliances, that shall enable us in all cases to furnish conclusions as to the condition of the nervous apparatus of the organ of hearing. Here, also, where science did not formerly seem to have even a foothold, we have very lately gained a place for genuine observation.

We must, also, endeavor to bring diseases of the ear and their treatment beyond the narrow boundaries of an exclusive specialism. In consequence of the great variety of the symptoms proceeding from the ear, and the seriousness of many of its affections, great errors in diagnosis, and many neglects and omissions in treatment can only be avoided, when a certain amount of the knowledge in this department has become the common property of all physicians, and when such a knowledge is indispensably required of every clinical teacher, as a prerequisite for the performance of his functions. The greatest possible simplification of the details of examination and treatment, will do very much toward rendering aural disease a subject for investigation and treatment in the largest circles of the profession. Modern time has also contributed very much toward this latter point.

After this general exposition of the matter in hand, I have to-day to unfold to you, the plan that I shall follow in these lectures, and what you may expect from our meeting together. I shall bring before you the different forms of diseases of the ear according to their

anatomical classification, describe their symptoms and make you acquainted with their treatment. I shall give you demonstrations of what I have to say, in preparations and pathological specimens from my collection, and a brief consideration of the normal anatomy of the parts will precede the description of their diseases, which will be also illustrated by appropriate preparations.

In connection with this theoretical instruction, I shall also assist you in the examination of the ear, with the otoscope or ear mirror, and catheter, in order that you may be able for yourselves to make a proper diagnosis as to the nature of the diseases of the ear, that may occur in your practice. It will please me very much, if I succeed in exciting in you a warm and permanent interest in the still much misunderstood, because not well known, diseases of the auditory apparatus. If this be the result of our meeting together, I know with certainty, that, in your subsequent life, you will thereby benefit your fellow beings and yourselves to a great extent, and thus derive great satisfaction from your labors.

LECTURE II.

ANATOMY OF THE EXTERNAL EAR.

I. Auricle and External Auditory Canal.

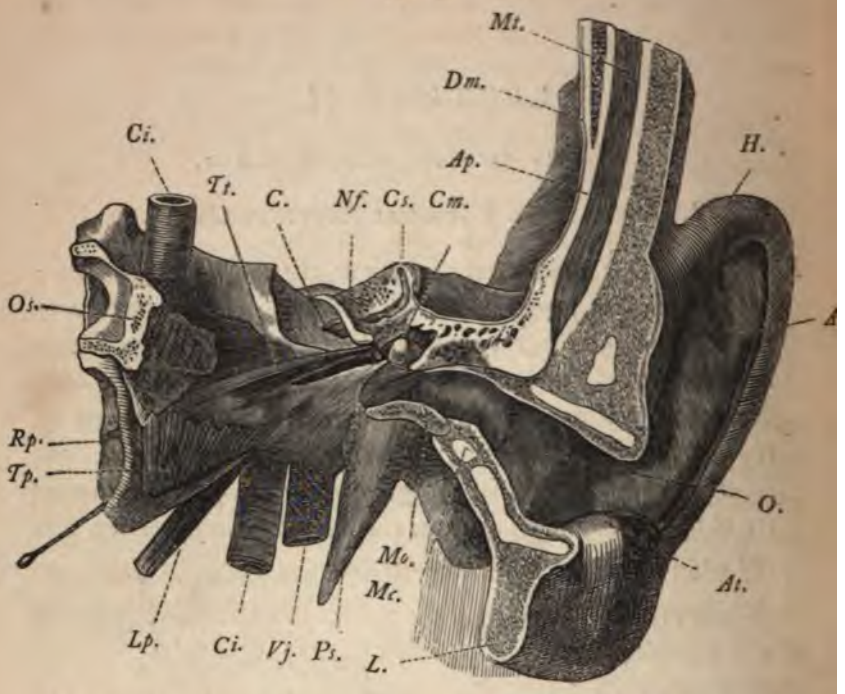
Physiological and anatomical division of the auditory apparatus; the auricle (its physiognomic significance); the structure of the external auditory canal in the child and in the adult; development of the osseous meatus, and the deficiency of ossification in the anterior wall; structure and attachment of the cartilaginous meatus; direction and course, size and form of the meatus; its integumentary lining; relation of its walls to the parotid gland, the maxillary articulation, and the dura mater; vessels and nerves.

Gentlemen: Before we begin the study of the diseases of the ear it will be necessary to become better acquainted with the organ itself, its situation and structure. On account of the directly practical aim of these anatomical observations we shall exclude everything which has for us no special importance.

The physiologist divides the ear into two parts; a perceptive, and a conducting apparatus. The anatomist gives the name of internal ear to the first part, i. e., the expansion of the auditory nerve in the labyrinth, together with the parts inclosing it, and divides the conducting apparatus, lying external to the former, into two parts, the middle and the external ear. The middle ear includes the cavity of the tympanum, the mastoid process with its cells, and the Eustachian tube with its muscles, while the

external ear consists of the auricle, the external auditory meatus, and the membrana tympani.

FIG. 1.



Topographical view of the entire auditory apparatus: left ear. H, helix. Ah, anti-helix. At, anti-tragus. L, lobule. O, entrance to the meatus, of which the anterior wall, together with the tragus, has been removed. Mc, cartilaginous meatus. At the end of the latter is seen the outer surface of the membrana tympani, and the handle of the malleus. Ps, processus styloideus. Vj, internal jugular vein. Ci, internal carotid artery, both before and after its passage through the petrous bone. Lp, levator palati; s, petro-salpingo-staphylinus. Tp, tensor palati; s, spheno-salpingo-staphylinus (abductor, or dilator tubæ). Between the two divided muscles is seen a part of the membranous portion of the cartilaginous tube. Rp, recessus pharyngis or Roseumüller's fossa, between which and the sound introduced into the cartilaginous tube projects the posterior cartilaginous lip of the ostium pharyngeum tubæ. Os, section

of the body of the sphenoid bone. Tt, musculus tensor tympani, running along the superior wall of the osseout tube, and projecting its tendon across the tympanum. C, cochlea, partially opened, with its opening into the vestibule. Cm, head of the malleus, behind it the body of the ambos. Above them the bony roof of the tympanum, covered by the dura mater. Op, oquamous portion of the temporal bone. Dm, dura mater. Mt, temporal muscle.

External Ear.—We begin with the external ear. This presents, in general, the form of a funnel with its larger opening directed outward, in order to receive external sounds. Its smaller and inner extremity is closed by the membrana tympani which assists in the further propagation of the sonorous waves.

The auricle is an elastic expansion adapted to the collection of sound, which it conducts into the external auditory meatus, in part by reflection, in part by participation in the sonorous vibration. In man its projection from the head is slight, and the development of its muscular apparatus is less than in most other mammalia.

The auricle in common with the external meatus, the Eustachian tube and the mastoid process, is that part of the auditory apparatus which completes its growth and development at the latest period, while the labyrinth hardly increases in size after birth, and the cavity of the tympanum and membrana tympani increase but little. These parts are subjected to many changes after birth, their development at that period being still very incomplete. (Some parts, such as the aqueduct and anterior process of the malleus, become even smaller after birth).

In regard to the size of the auricle in the embryo, I have made a series of measurements and obtained the following results, which in doubtful cases may be of service in determining the age of the fœtus. The longest or vertical diameter measures in a fœtus of 10–11 weeks, 2 mm.; of three months, 4–5 mm.; of four months, $5\frac{1}{2}$–$7\frac{1}{2}$ mm.; of five months, 8–12 mm.; of six months, 14–17 mm.; of seven

months, 16–24 mm.; of eight months, 26 mm.; of nine months, 26–28 mm.; of the new born infant, 33–36 mm. It should be remarked that these measurements were made from preparations in alcohol. If made on the fresh subject, they might be somewhat greater. After birth the auricle increases much more in length than in breadth; as do also the meatus and membrana tympani.

The size and form of the auricle, and the angle which the auricle forms with the lateral wall of the skull, are subject to great individual variations. Many of these are frequently observed as family characteristics, while many may be considered as national and ethnological peculiarities. The auricle may vary in respect to its length or breadth, its roundness or angularity, its flatness or concavity. It often lies closely applied to the head in females, as a result of constant pressure from the covering of the head, or in children from long continued chafing at its angle of attachment. In advanced age the auricle becomes more relaxed.

It is well known that *Lavater* attributed a certain physiognomic significance to the form of the auricle. Dr. *Amédée Joux*,[1] in more recent times, goes further, and draws most minute conclusions in regard to an individual's character from an examination of this organ. A white, pliant ear, of symmetrical and elegant form, with a faultless lobule, of becoming size, which is nicely attached to the head, can belong to no vulgar or even mediocre individual. But if the auricle be red and thick, if its lobule be large and injected, if its component parts be not in just proportion, if it stand in improper relation to the neighboring parts, if it have an animal or unpleasing shape, then its possessor has been slighted by nature; his tendencies are ignoble and blameworthy. *Joux* further asserts that no other organ of the human body so uniformly descends, still retaining its peculiar features, from father to child; and that this fact may frequently assist in determining the legitimacy of children, and the conjugal fidelity of a mother. "*Montre-moi ton oreille, je te dirai qui tu es, d'où tu veins et où tu vas.*"

[1] Gazette des Hôpitaux, Févr., 1854.

The external auditory canal is a tubular continuation of the auricle, from which it is separated by no well marked boundaries. Its outer extremity is open, whilst internally it is closed by the membrana tympani. The dog and cat are not only blind at birth; but there also exists in them a condition of the auditory meatus analagous to that of the eyelids. On the twelfth or fifteenth day after birth, and the second or third day after the opening of the lids, the membrane which closes the meatus breaks up, still leaving remnants which partially close the entrance to the passage. It is possible that the stoppage of the auditory meatus with *vernix caseosa* and the proximity to each other of the walls of the meatus in the vicinity of the membrana tympani may constitute a similar condition in the new born of the human species. (As is well known, many birds have the enviable power of stopping their ears at pleasure by means of a kind of valve. The turkey possesses an erectile tissue projecting into the meatus, so that it can close the ear more or less perfectly when angered). The membrana tympani in the child lies at the outer surface of the skull, but in the adult at the bottom of an osseous canal, formed by the temporal bone. Hence, in the infant the passage leading to the tympanic membrane is formed only of cartilage and soft tissue, of which a portion has become ossified in the adult. In the latter, therefore, we divide the meatus into a cartilaginous and an osseous portion.

During the earlier period of its life the child possesses no osseous meatus. The statement, however, of many authors that the meatus of the child is wholly cartilaginous is incorrect. The outer portion of the passage is cartilaginous in both child and adult, while in the former the inner portion consists of a membranous tube, to which the cartilaginous portion is attached, precisely as it is afterward attached to the osseous portion. In the newly born this inner, membranous portion constitutes about one-half

of the whole canal; but it gradually becames shorter as the development of bone progresses outwardly. (Since, however, the membrana tympani of the infant is nearly horizontal, and lies therefore in a plane with the superior wall of the meatus, we must limit the term membranous meatus, to the inner portion of the inferior and anterior walls).

This slow development of the osseous meatus is only partially accomplished by the addition of a new osseous portion. The superior and posterior walls are formed by a change in the confirmation of the temporal bone, coincident with the general growth of the skull. As the flat, undeveloped mastoid process of the child increases in size and convexity, the depression in the squamous portion of the temporal bone, at first quite superficial, and containing at its bottom the membrana tympani, increases in depth. On the contrary, an addition of osseous substance is made to the anterior and inferior segments of the *annulus tympanicus*, the osseous ring which, in the fœtus, is quite independent, and to which the periphery of the membrana tympani is attached. In this way there gradually arises an osseous plate, which is convex anteriorly, and attached posteriorly, to the mastoid process, superiorly to the squamous portion of the temporal bone. Thus the superior and posterior walls of the osseous meatus are formed in one way, while the anterior and inferior walls are developed in another.

This addition of osseous tissue does not progress outwardly with regularity, but in such a manner as to leave at first a rounded notch, which finally becomes a nearly circular foramen, filled up with connective tissue.

The time required for the complete filling up of this foramen seems to vary materially in different individuals. I looked in vain for it in the skull of a child 2½ years old, and also of another 3 years old, while in

most cases its diameter is as great as that of a cherry pit. On the "skeleton of a child five years of age," in the anatomical museum at this place, the foramen measures about 3 mm. in diameter: and in some other skulls of young subjects which possess the osseous meatus of full length, foramina of various sizes are still present. In all others of this age the corresponding part of the meatus is so thin as to be quite translucent.

Any one who is not aware of this peculiar method of ossification in the meatus of the child, might easily mistake this opening, with its thin and irregular margins, for a pathological condition, the result of caries, especially if the process of caries is going on the vicinity. This peculiarity is by no means generally understood. I assure you that even celebrated anatomists, when I have shown them normal preparations illustrating this peculiarity, have declared that the foramina were pathological. In inflammations of the meatus this foramen may be of further practical importance, since the membrane closing it may be easily broken through by the suppurative process, and the disease be thus propagated to the maxillary articulation or the parotid gland.

The scanty accounts which we find in regard to this deficiency of ossification in the anterior wall of the osseous meatus of the child, show how little the attention of anatomists has been drawn to it. The fullest account of it is given by *Huschke*, in his edition of *Sömmering's* Anatomical Manual.[1] He asserts that it does not become perfectly filled up until the fourth year, and considers it the analogue of the *incisuræ Santorini* of the cartilaginous meatus. In *Arnold's* Manual,[2] which in other respects treats exhaustively of the ear, it is but briefly mentioned. *Henle*[3] alludes to this foramen as an oft occurring "variety." Of the older anatomists, *Cassebohm*[4] (*Tractatus quatuor anat. de aure humana, Halæ*, 1734, *p.* 28), gives a very good account

[1] 1844, p. 896. [2] 1845, I, p. 402. [3] Manual 1855, p. 142 and 151.
[4] Handbuch, § 142 et 157.

of it: "Paries anterior in medio foramen habet, in infante aliquot annorum magnum; in juvine autem et adulto disparens, quia evaluit." In Tab. I, fig. 2, he shows, by means of a circle drawn on the petrous bone of an adult, the spot "ubi foramen in puero observatur." The above mentioned drawing is probably the first which was made of this foramen from nature.

The length of the auditory canal varies considerably in different subjects. Its average length in the adult is about 1 inch, or more accurately, 24 mm. The cartilaginous meatus constitutes about one-third (8 mm.) of the whole, and the osseous meatus the remaining two-thirds (16 mm).

The cartilage is not immediately attached to the bone, as is the cartilaginous Eustachian tube to the osseous, but the two sections of the meatus are joined by means of an interposed membranous layer, which may be regarded as a residuum of the inner membranous half of the meatus; the cartilage even partially surrounds the outer border of the osseous canal. In this way a certain degree of extensibility of the meatus is effected, and its mobility further increased by the peculiar form of the cartilaginous meatus. This has not the form of a perfect cylinder, but only of a semi-cylinder, which is completed superiorly for a considerable portion of its extent by membrane, and which resembles the trachea in this respect, that the cartilage possesses several regular incisures, *incisuræ Santorini*, which are filled up by membranes.

The external extremity of the cartilaginous meatus, on the contrary, is on all sides continuous with the auricle. There are no well marked boundaries between the two, and every movement of the auricle is participated in by the cartilaginous meatus.

In regard to the direction and course of the external auditory canal, as a whole, it is usual to describe so many curvatures, angles and projections, that the student becomes confused. A better knowledge may be obtained by a de-

scription which omits these anatomical details. For this examination the living subject is better than the dead; but if the latter is used the soft parts must be previously hardened, since otherwise they are easily displaced by the dissection, and one would draw wrong conclusions in regard to their relations.

The most essential factor in the production of the sinuosity of the external auditory meatus is the rounded angle at the junction of the osseous and cartilaginous portions of the canal. The longitudinal axes of the two portions do not lie in the same plane, but meet at an obtuse angle, whose opening is directed downward and forward. This angle, which projects more or less into the caliber of the meatus, forms, to a certain extent, the ridge from which each division descends, the cartilaginous to the outer extremity of the canal, the osseous to the membrana tympani, both running downward and forward; the inclination of the osseous portion, however, being always less than that of the cartilaginous.

The inclination is always greatest along the inferior wall of the cartilaginous meatus. Hence it results that, while the membrana tympani and outer extremity of the meatus lie in the same horizontal plane, the outer opening lies much below the lower margin of the membrana tympani. The superior wall of the external auditory meatus runs also very nearly in a straight line, while the lower wall makes an obtuse angle at the point of junction of the osseous and cartilaginous portions. In the child, even after a part of the osseous meatus has appeared, the inferior wall is much straighter than in the adult.

If we now examine the various diameters of the auditory canal, we are enabled to make certain more minute detailed observations in regard to the various curvatures, dilatations and contractions of this canal.

It should be remarked in general, that both the caliber

and form of the external auditory canal vary exceedingly in different individuals. Even in the same individual, the two sides are frequently unsymmetrical. In order to convince one's self of the great diversity of size and form, e. g., of the external extremity of the osseous meatus, it is only necessary to examine a number of macerated petrous bones. You will hardly find two alike in this respect. In some, the opening will be nearly circular, in others oval; in one, the meatus will be nearer straight than in another, while the inclination of the axis of the meatus will vary. In the adult the transverse diameter of the canal is generally greater than the vertical, and a section of the canal has always an oval or elliptic form. The longest diameter of this oval is nearly vertical at the outer extremity of the cartilaginous meatus; but it soon changes from this vertical direction, and runs downward and backward.

Just behind the tragus, which projects somewhat over the entrance to the meatus, the canal, in its antero-posterior diameter, is smaller than at any other point, while its vertical diameter is correspondingly great. Soon thereafter the vertical diameter decreases and the horizontal diameter increases, the canal becoming lower and broader. There is another contraction in the transverse diameter a short distance from the membrana tympani, and finally just outside of this membrane a considerable depression in the lower wall. This latter is of considerable practical importance, because small foreign bodies frequently lodge in it, and easily escape the observation of the surgeon.

In the small child the inner half of the auditory meatus is really no canal, because the membrana tympani, which at this period lies nearly in a horizontal plane, is throughout its whole extent in contact with the lower wall of the canal. This relation is facilitated by the thickness of the epidermic layer of the membrana tympani.

The lining of the external auditory canal is a continua-

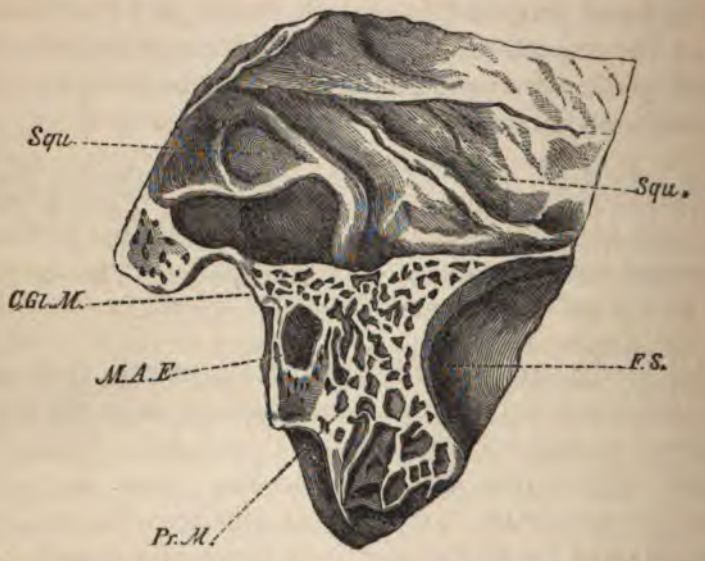
tion of the common integument. In the cartilaginous meatus it has considerable thickness, and preserves the general characteristics of the skin. It possesses, in old people especially, a great number of hairs with their sebaceous glands, the well known ceruminous glands. These have the same form, and the same long excretory ducts, that are found in the common sudoriferous glands, and hence might properly be called the aural sudoriferous glands. They are so large as to be visible to the naked eye, as small granules of about the size of poppy seeds, and lie in the superior layers of the sub-cutaneous cellular tissue. They are most abundant in the inner half of the cartilaginous meatus.

On the cadaver, the orifices of the ducts of the sebaceous glands can be seen with the naked eye, as fine apertures, especially if the macerated epidermis be removed in large pieces. At the same time small bulbs will be seen hanging to the epidermis. These are the hair follicles and their sebaceous glands.

Along the upper wall of the osseous meatus there is a strip of integument of the same character as in the cartilaginous meatus. Externally this strip is quite broad, but it gradually becomes narrower, and finally ends in a point near the membrana tympani. In the remainder of the osseous canal the integument is destitute of subjacent cellular tissue, of the large hairs and glands, and is thinner and smoother; but it is still made up of separable lamellæ, and is provided with finer hairs and papillæ, arranged in regular lines extending to the immediate vicinity of the tympanic membrane. Although the integument of the osseous meatus is thinner and more delicate it cannot be considered a mucous membrane, as has been stated by many authors. It is certainly no more than an example of the transition stage between mucous membrane and external integument, such as is seen in other places where

the one kind of tissue gradually passes over into the other, as at the margins of the nostrils, on the lips, etc. This cutis, which becomes gradually thinner as we approach the membrana tympani, is so intimately connected with the periosteum (the glands and subcutaneous cellular tissue being absent) that the latter cannot be easily isolated; at least, it is more easily separated from the bone than from the cutis.

FIG. 2.



Vertical section of the osseous meatus, right side, close to the membrana tympani. M. a. e., external auditory meatus. C. gl. m., articular fossa of the inf. maxilla. Squ., inner part of the squamous portion of the temporal bone. The dura mater has been removed, and we see the prominences and depressions (Iuga cerebralia et impressiones digitatæ), and superiorly a groove for one of the vessels. F. s., fossa sigmoidea for the sinus transversus. Pr. m., mastoid process, with the outer portion of its cellular system.

In regard to the relation of the external auditory meatus to the neighboring parts, it may be said that the cartilaginous portion is bounded anteriorly and inferiorly by the

parotid gland, and cases have been observed where abscesses of the parotid have discharged into the auditory canal through the incisuræ Santorini. It is evident, also, that enlargements of the parotid or of the lymphatic glands may contract the canal by pressure.

The anterior wall of the osseous meatus forms also the posterior wall of the articular fossa of the inferior maxilla. Hence a blow upon the chin may produce a fracture of this plate, and cause a hemorrhage from the ear. The comparative infrequency of such results of a fall or blow upon the chin are explained by the fact that the thick cartilage of the articulation in question, in a degree, protects the temporal bone from the full force of the blow.

The posterior wall of the osseous meatus is made up by the mastoid process in such a way that the canal is separated from the transverse sinus only by two thin plates of compact osseous tissue and the air cells lying between them. The superior wall is covered on its upper surface by the dura mater, and forms a portion of the floor of the middle fossa of the skull. This plate of bony tissue, lying between the brain and auditory canal, varies in thickness in different individuals, being sometimes extremely thin. It is always provided with open spaces containing air, and continuous with the cavity of the tympanic and mastoid cells. There sometimes exists but a very loose osseous structure between the integument of the meatus and the dura mater; which fact may be of great practical importance, and may explain how inflammations of the meatus, which are apparently slight, occasionally produce severe and even fatal encephalic disease. Besides it is important to fully understand that the meatus is bounded superiorly and posteriorly by hollow spaces which belong to the middle ear. Thus it is seen that a portion of the "middle ear" lies much external to certain portions of the "external ear," e. g., the membrana tympani. The general

conception is, that the "middle ear," in all its parts, lies nearer the median line than the "external ear;" but this is not wholly true. When we come to study secondary abscesses of the auditory meatus, and some other cases also, we shall again refer to the relation of the air spaces of the temporal bone to the external auditory meatus.

Blood Vessels.—The auditory canal receives its blood from the posterior auricular artery (maxillaris ext.), which sends branches also to the auricle, and from the deep auricular artery (maxillaris int.) which enters at the maxillary articulation, supplies the tragus, and distributes branches to the inferior, anterior and superior walls of this canal. The veins of the external ear, empty in part into the temporal vein, a part into the external jugular veins, or also into the trunk of the posterior facial vein.

Nerves.—The posterior side of the auricle is supplied by several large branches of the third cervical, while the anterior side receives branches from the auricularis anterior, of the third branch of the fifth. The meatus receives one or two twigs from the sensitive auriculo temporalis nerve from the third division of the tigeminus; these penetrate its anterior wall, between the cartilaginous and osseous sections. The integument receives in addition an auricular branch of the pneumogastric or vagus, which rforates the anterior wall of the osseous meatus.

The development of the meatus shows that the pneumo-gastric rve sends a branch to the ear, as well as to the lungs and stomach, e the external auditory canal is formed from the first bronchial This auricular branch of the vagus, in the human subject, vered and first described by *Arnold* in 1828.

LECTURE III.

ANATOMY OF THE EXTERNAL EAR.

II. Membrana Tympani.

Importance of a thorough knowledge of the membrana tympani; it must be studied on the living subject rather than on the cadaver; Rivini's foramen; arrest of development; attachment (sulcus and annulus tympanicus); size in the adult and in the fœtus; the handle of the malleus; umbo; posterior and anterior pouch; curvature and inclination of the membrana tympani; its color; luster; triangular spot of light; its anatomical structure; its outer and inner covering, and fibrous layer; vessels and nerves.

Gentlemen: The membrana tympani forms the partition wall between the external auditory meatus and the cavity of the tympanum. It belongs to both these divisions of the ear; first, by reason of its position, and secondly, because the tissues which enter into its composition, and because its vessels are derived from both directions. Some anatomists have therefore described it under the name of middle ear; but it belongs more properly to the external ear, because we find it corresponds to the gill cover and integument of the gill cover of fishes, and therefore belongs to the surface.

The examination of the membrana tympani is one of the most essential diagnostic means which we possess in diseases of the ear. This is because the appearance of the membrana tympani gives us important information in

regard to the state of both the external meatus and the cavity of the tympanum, and because it is so easily accessible to a direct examination.

It must therefore appear strange that the drum of the ear has been so briefly described, even in those text-books of anatomy which are considered practical. But the anatomist has not the opportunity to obtain perfectly correct and minute knowledge of the ear-drum in all its parts. The anatomist obtains his knowledge of this part from observations on the cadaver only. But as a description of the cornea, according to its appearance some days after death, cannot give a correct idea of the properties of this organ, so is it also in the case of the ear-drum, which, on account of its delicacy, the fact that it is covered by a fine layer of epidermis, and the dependence of its curvature upon a muscle of striped fiber (the tensor tympani), has in the cadaver an appearance entirely different from that in the living subject.

The great errors to which we may be led by the study of the anatomy of the membrana tympani, from dried preparations, are illustrated by the fact, that for two hundred years many anatomists have asserted that there was a normal opening in the membrane; when this opening, called Rivini's foramen, is nothing more than a rent, occurring in the desiccation of the half macerated membrane, as was first demonstrated by Hyrtl.

Rivini's foramen was not first described by *Rivinus*, professor in Leipsic (1689), but had already been described by *Glaser* (1680), and *Emanuel König* (1682), professors in *Bâle*. *Friedr. Ruysch* and *Valsalva* (1704) denied the existence of a normal opening in the human membrana tympani; but *Berres*, *Hyrtl's* predecessor in Vienna, believed in its existence and described it minutely. From the first, however, the opening was very differently described; some authors finding it in the center of the membrane, others near its upper border; some describing it as large, others as small.

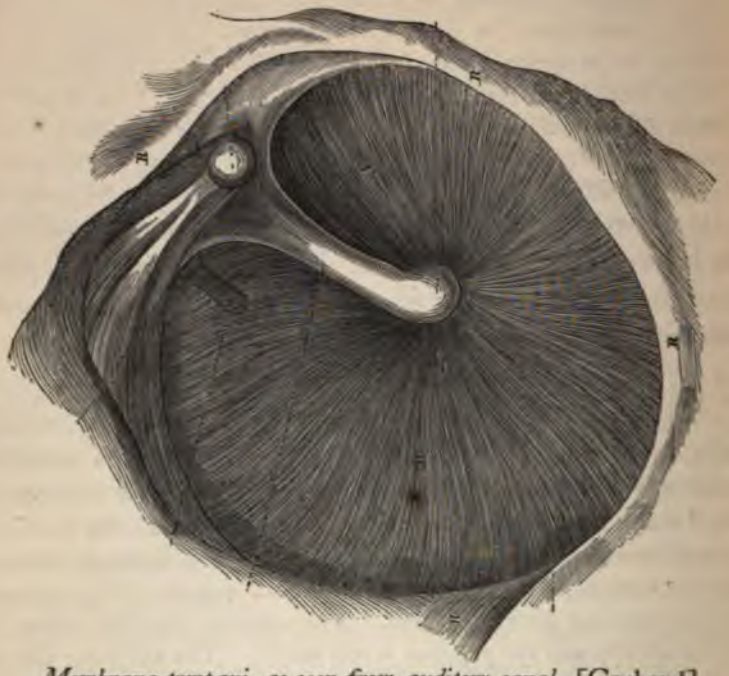
Quite recently *Bochdalek*, professor of anatomy in Prague,[1] has described Rivini's foramen as a constant opening in the membrana tympani; sometimes, he says, there are two. It is, however, so small that its presence is only demonstrable by a magnifying glass, or a bristle introduced into it. We should persevere, "for hours" if necessary, in attempting to find it, as the discoverer remarks.

Since, according to *Huschka*, the ear-drum is not closed at its upper part during the early portion of embryonal life, and is even entirely wanting at first, an opening in it may occur from arrest of development, as in harelip or coloboma iridis.

I have in my possession the petrous bone of a subject in which both membranæ tympani have an opening at their upper part of about 3 mm. in diameter. Since both drums have precisely the same appearance, and there is no sign of preceding inflammation and ulceration, I think it reasonable to infer that the foramina are the result of arrest of development. Again, in a young man who had cleft palate, I found an opening in the membrana tympani of one ear. This ear was in other respects perfectly sound. The opening extended obliquely downward opposite the *processus brevis mallei*. The other ear was so much affected by otorrhœa that I could not decide upon the state of its membrana tympani. Finally, in the case of an old man, who had never had any aural disease, both drums presented at their upper border a shallow, rounded depression, about 2 mm. broad, which appeared to be caused by an absence, at that place, of the tunica fibrosa. After the air douche, the depression became an elevation. These states of the membrana tympani, which certainly are but rarely observed, are best explained in the manner mentioned above.

[1] Prager Vierteljahrschrift, 1866, I.

FIG. 3.



Membrana tympani, as seen from auditory canal. [Gruber.[1]]

The membrana tympani, a thin elastic membrane, lies at the inner extremity of the external auditory canal, and is attached to an osseous groove, the *sulcus tympanicus*, which is only interrupted superiorly. If this groove were present above, the method of attachment of the membrane might be compared to that of a watch crystal in its case, or of a picture in its frame. This attachment is effected by means of an annular strip of thick white connective tissue, which encircles the outer border of the membrane, and, like the sulcus tympanicus, is wanting only at the upper part at both sides of the short process of the malleus. (Most authors incorrectly call this the annulus carti-

[1] Das Trommelfell, Wien, 1867.

lagineus.) The attachment of the membrane is least firm at the upper and posterior portion; the membrane at this point going over immediately into the integument of the meatus. This is the point where the membrana tympani would be most easily detached by any pressure from inside, e. g., by excessive pressure from the air douche.

The osseous portion which surrounds the membrane and encloses the sulcus tympanicus is, in the fœtus, a detached part of the temporal bone, and is called the *annulus tympanicus*. Its ossification occurs very early, and gradually there are developed from it the inferior and anterior walls of the meatus.

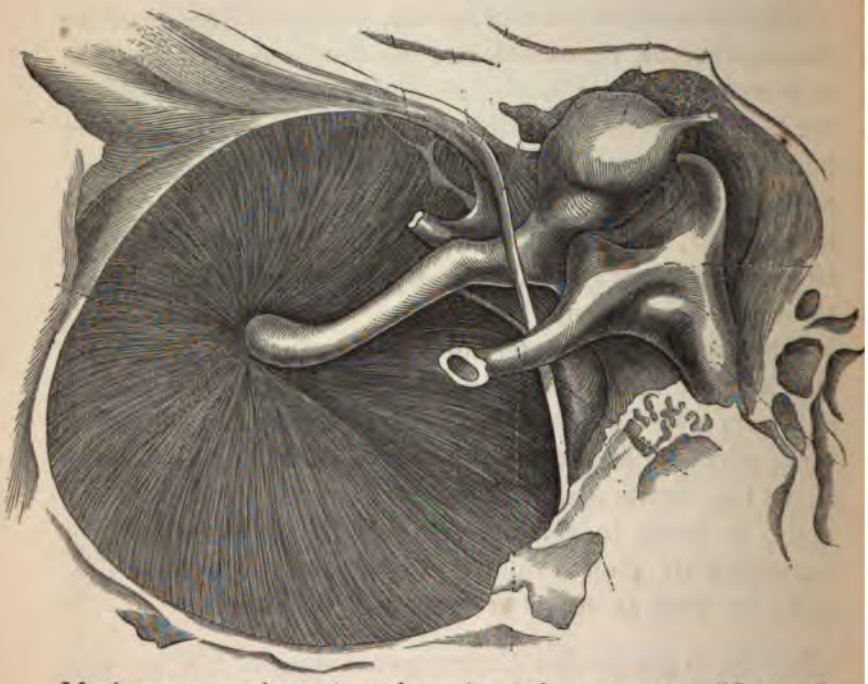
The form of the drum of the ear, like the diameters of the osseous meatus, varies in different individuals. In the child it is nearly circular, whilst in adults it is more elliptical, the long diameter coinciding with the vertical; frequently, however, it is irregularly heart shaped. At the upper part, where what was formerly called the annulus tympanicus is interrupted, there frequently projects a variously shaped, irregular prolongation (about 1 to 2 mm. in hight) into the wall of the osseous meatus.

The different diameters of the membrana tympani are also subject to important individual variations. In the adult its average vertical diameter is between 9 and 10 mm., while its horizontal diameter is 8 or 9 mm. In the fœtus the membrane, in its proportion to the length of the body, is much longer than in the adult, since it nearly completes its growth during the last month of fœtal life, and after birth increases at most only in length.

In order to gain accurate data in regard to the growth of the membrana tympani in the fœtus, I made a measurement of it, in a series of skeletons of embryos of from three to nine months. The skeletons I found in the anatomical museum at this place. Prof. *Kölliker* was good enough to make for me an estimate of the age of each, and I have added the length of the body in each case. In a fœtus of 11

weeks (length of body 56 mm.), the height of the ear-drum was 2 mm., its breadth $1\frac{1}{4}$ mm.; in a fœtus of 14 weeks (84 mm.), the same diameters 3 and 2 mm.; in one of 16 weeks (114 mm.), $4\frac{1}{2}$ and 3 mm.; in one of 20 weeks (155 mm.), 7 and $5\frac{1}{2}$ mm.; in one of 22 weeks (220 mm.), 8 and 7 mm.; in one of 24 weeks (290 mm.), $8\frac{1}{2}$ and 8 mm.; in one of 7 months (335 mm.), 9 and 8 mm.; in one of 8 months (370 mm.), $8\frac{1}{2}$ and 8 mm.; finally, in one of 9 months (450 mm.), $9\frac{3}{4}$ and $8\frac{1}{2}$ mm. The fact that the longest diameter of the fœtus of seven months was greater than that of another whose length of body was nearly 40 mm. greater, shows that many variations may here occur, caused by the different degrees of development of the above mentioned prolongation of the superior border of the drum.

FIG. 4.



Membrana tympani seen from the cavity of the tympanum. [Gruber.]

On examining the membrana tympani from the outer side, we first notice the handle of the malleus (*manubrium mallei*), which extends, as a whitish yellow stripe, from the

anterior and superior border downward and backward to about its center. This stripe, if prolonged to the inferior pole, would divide the membrane into an anterior and a posterior half, of which the latter would be the greater. At the upper end of the handle of the malleus, just below the prolongation of the upper border of the drum, we see the processus brevis (*abtusus*) mallei, or short process, as a small, white, rounded tubercle, projecting toward the meatus. From the processus brevis the handle of the malleus inclines inward toward the cavity of the tympanum, the drum being concave outward and convex inward. This curvature is greatest at the lower end of the handle; and this most concave portion of the ear-drum, lying a little below its center, is called the "umbo," or umbilical contraction of the drum.

By the "umbo," all the later anatomists understand that point near the center of the membrane where the curvature is greatest. Some aurists, however, copying many of the older anatomists, describe, under "umbo," the projection of the short process of the malleus at the upper extremity of the ear-drum. This double use of a term causes much ambiguity, and should be avoided. The umbilicus is in all cases a depression, except in the new born child, and in the female during the later period of gestation. The English, e. g., Toynbee, also call the handle of the malleus the long process of the malleus, while we understand by *processus longus* the Folianian process, which extends forward into the Glaserian fissure, and can be seen in children only.

If we now examine the membrana tympani from its inner side, we see that the head and neck of the malleus project into the cavity of the tympanum. The incus, articulates with the posterior surface of the head of the malleus. Its long or vertical process lies close to the posterior and upper part of the membrana tympani, and behind and parallel with the handle of the malleus, without, however, descending so far as the latter. Below it we notice a peculiar appendix, or

supplementary leaf of the drum, which has hitherto escaped the observation of anatomists, because it is usually concealed by the body and long process of the incus. On the inner side of the membrane, at the upper part of its posterior half, is found an irregularly triangular fold, about 3 or 4 mm. high, and 4 mm. broad, which arises close behind the osseous border to which the membrana tympani is attached, and extends to the handle of the malleus. Thus there is formed a not inconsiderable cavity, open below, and increasing in depth from above downward, for which I have proposed the name of "posterior pouch, or pocket (Tasche) of the membrana tympani." Along the posterior portion of the free, concave border of this duplicature runs the chorda tympani, which afterwards ascends toward the neck of the malleus; thus leaving below it the deepest portion of this duplicature as a small triangle. We obtain the best view of this duplicature, and of the pouch formed by it, by viewing the drum from the inside, while it is still in its position in the temporal bone, and after the pyramid, or at least the entire roof of the tympanum, has been removed, and the incus detached from its articulation with the head of the malleus; hut we can see it from the outer side, and even in the living subject when the illumination is good, and the membrane very transparent.

The above described duplicature assists essentially in holding the malleus in position. After it has been divided, this bone is much more movable than before. This leaf of the posterior pouch consists of the same variety of fibers that characterize the lamina fibrosa of the ear-drum. It is further shown to be an integral part of the membrane, by its origin from the annulus tympanicus, as can be demonstrated on the infant, whilst the chorda tympani emerges from the bone lying next to the former and genetically separate from it. In the cadaver we often find the two inner surfaces of th own together, either partially or

totally, as a result of catarrhal processes in the cavity of the tympanum. In this way the normal cavity is either decreased in size or wholly obliterated.

A similar enclosed space is found in front of the malleus; but this anterior pouch of the membrana tympani is not formed by a duplicature of the fibrous layer, but by a small bony process, turned toward the neck of the malleus; by the mucous membrane which lines every part of the cavity of the tympanum, and by all the parts which proceed from, or enter the Glaseri fissure; by the long process of the malleus, which, as we have seen, is fully developed in the child only; by the ligamentum mallei anterius, the chorda tympani, and the inferior tympanic artery. This anterior pouch or pocket is lower and shorter than the posterior.

These "pouches of the membrana tympani" were first described by me in the Würzburg Transactions for 1856 (Sitzungsberichte, S. XXXIX), afterwards in my "Contributions to the Anatomy of the Membrana Tympani," (Siebold und Kölliker's Zeitschrift für Wissensch. Zoologie 1857, IX, B. S. 94). They are noticed in Arnold's *Icones organorum sensuum* (1839), Tab. VI, Fig. XVII. In the text, they are called "Plica membranæ mucosæ anterior et posterior;" whence we infer that he considered them as folds of the mucous membrane only. He did not think them constant, or worthy of further mention, since in all the other illustrations in which the drum is seen from the inner side, and especially in Fig. XX, Tab. V, where "Membranæ facies interna" is shown after the removal of the incus, by which the posterior pocket is made easily visible, they are not seen; nor does he mention them in his text-book of anatomy (1851), in which, in other respects, the ear-drum, and in fact the whole auditory apparatus, is exhaustively described. *Henle*, in his text-book of systematic anatomy (1866, II, S. 750), describes this supplementary leaf of the drum in full, but considers it one of the folds of mucous membrane of the cavity of the tympanum. I cannot believe that the expression of this opinion was preceded by a microscopic examination of the elements of this part. According to *Wildberg* ("Versuch einer anatomisch-physiologisch-pathologischen Abhandlung über die Gehör-

werkzeuge des Menschen," Jena 1795, S. 95), it appears that the older anatomists were acquainted with this duplicature of the drum, and considered it a muscle, (musc. mallei superior, also called laxator tympani minor). *Prussak* has lately described an upper pouch or pocket, whose outer surface is formed by the above named membrana flaccida, and the inner by the outer surface of the neck of the malleus, and which is only seen posteriorly above the posterior pocket.

If we now study more closely the curvature and the inclination of the drum, we remark, first of all, that although the membrane, as a whole, is made concave externally by the traction of the malleus, it still normally curves somewhat forward in some parts.

Thus the anterior and lower part, from the umbo to the border, presents a pretty well developed convexity outward; besides, the short process of the malleus produces, at the upper pole of the ear-drum, a small but very decided bulging, from which there frequently proceed two folds, the shorter running forward, the longer running backward.

The inclination of the membrana tympani is also somewhat difficult to understand. The membrane is placed obliquely at the end of the auditory canal, obliquely in two senses; that of its vertical, and that of its horizontal diameter. In this way it forms with the lower and anterior wall an acute angle, but with the upper and posterior wall an obtuse angle. The anterior border of the membrane is farthest removed from the outer extremity of the canal, the lower border next, then the posterior, and finally the upper border. If a perpendicular be drawn from the upper pole of the drum it will meet the lower wall of the auditory canal at a point about 6 mm. from the lower pole of the membrane. The peculiar obliquity of the drum, is determined by the varying length of the different walls of the auditory meatus; that is, by the inclination of the osseous ring, bounding the auditory canal internally, in which the membrana tympani is inserted.

This osseous ring, which for a long time possesses a certain independence, forms however an integral part of the base and lateral wall of the skull. Hence the fact is explained, that its position and inclination depend, to a certain extent, upon the existing degree of development of the whole skull, whether the completion of this development proceeds according to the laws of physiological growth, or is subjected to morbid disturbances and arrests.

In the fœtus, the annulus tympanicus and the ear-drum lie quite horizontally, forming a portion of the base of the skull. Even in the new born child the membrane has a nearly horizontal position, and forms, with the upper wall of the meatus, nearly a straight line. The upper pole of the drum must therefore, in the new born, be properly called the lateral pole; and it lies pretty near to the outer extremity of the meatus. This horizontal position of the membrane in small children makes the difference between the length of the lower and that of the upper wall very great. Indeed, the lower wall is twice as long as the upper, of which the membrana tympani is the continuation. As the skull becomes developed, the membrane gradually approaches a vertical position. Still its inclination in the adult is subject to great individual variations, which probably depend not only upon the position of the squamous portion of the temporal bone, but also upon the lateral and longitudinal development of the base of the skull; so that we can, perhaps from the degree of inclination of the membrane of the living subject, decide in regard to the higher or lower portion of the sphenoid bone, and the history of development of the skull in general. The best measure of the degree of inclination of the drum is given by the angle which it makes with the upper (or with the posterior) wall of the canal; and this is, perhaps, also the easiest way of obtaining it. A series of measurements on the

normal ears of adults gave an average of 140° for the angle above mentioned.

Bonnafont and *Schwartze* found a very striking vertical position of the membrana tympani in musicians. I may add to this, that in persons with no musical taste, the very oblique position of the membrane was marked. *A. Feck*[1] has shown that the membrana tympani cannot be so much put in motion by vibrations of sound with its oblique position, as would be the case if it were perpendicular to the auditory canal.

In a deaf mute of 35 years of age, who was reported to be a cretin, the membrana tympani formed an angle of 167° with the upper wall of the meatus; about the same as that of a child. Since I possessed the middle portion only of the base of the skull, I could make no estimate of the clinoid angle, nor form any opinion in regard to synostoses, and arrests of development in the base of the skull. (Voltolini also found, on dissection, a nearly horizontal position of the drum in two deaf mutes. One subject was 16 and the other 17 years of age.[2]) That the degree of the angle of the drum should remain, in such cases, equal to that of the child is something very striking; however, Virchow has already shown, in his classical investigations in regard to cretinism, and the development of the base of the skull, that a certain relationship exists between cretinism and deafmutism. (In order to decide whether this position of the ear-drum is constant in cretins, I examined all the skulls of cretins that are to be found in the institution at this place, but found them untrustworthy from the maceration and drying which the skulls had undergone; but the results which I did obtain, although uncertain, incline me to the opinion that this position is constant.)

The measurement of angles in those parts to which we cannot directly apply the quadrant, or of which we cannot obtain good sections in profile, is very laborious. It can best be made by drawing a whole system of parallel lines, and determining from them the angle in question. Quite recently I have been enabled to estimate, with great ease, the angle of the membrana tympani by means of a simple and ingenious apparatus, which William Hess, teacher of mechanics in the Gewerbschule, of Würzburg, contrived especially for this purpose.

[1] Anatomie und Physiologie der Sinnesorgane, Lahr 1864, S. 135.
[2] Virchow's Archiv, B. XXII, S. 127, and B. XXXI, S. 212.

The normal membrana tympani is very thin, about as thick as very fine letter paper, or gold beater's skin. According to *Henle* it is about 0.1 m. in thickness. This delicacy causes it to be transparent, and makes it very liable to perforation. It is also quite elastic, so that it will bear considerable pressure, either from within or without, without rupturing.

The color of the membrana tympani must be studied on the living subject; the statements of anatomists in regard to it are of doubtful value. On the cadaver this part is dull, whitish and opaque, on account of the loosening and maceration of the epidermic layer; on the living subject it is lustrous, pearly gray, and translucent.

We shall here follow the excellent descriptions of Politzer.[1] "First of all, we must consider that the drum is a so called translucent medium, which reflects a portion of the light thrown upon it, but allows another portion, sufficient to illuminate the tympanum, to pass through it. From the promontory on the opposite wall of the tympanum a portion of this light is reflected, which again traverses the membrana tympani with some loss, and reaches our eye. The color of the drum is therefore one of combination, made up of the proper color of the membrane, that of the light used for the examination, and of the quantity and color of the rays which reach us from the promontory. In those cases in which we describe the membrana tympani as of normal appearance, we can compare the color of the membrane, as seen by ordinary daylight, to a neutral gray, with the addition of a weak tone of violet, and light brownish yellow."

The thinner and more transparent the membrana tympani, and the less its obliquity, and the smaller its distance from the parts of the cavity of the tympanum, the more influence

[1] Beleuchtungsbilder des Trommelfells im gesunden und kranken Zustande, Wien, 1865, S. 14.

will the latter exercise upon the color of the membrane; in other words, the more will light reach us from them. Thus, we often see the middle of the membrane, the umbo, and the point immediately back of it, appearing yellowish gray, in consequence of the reflection from the promontory; so, also, the long crus of the incus behind and parallel to the handle of the malleus, although not reaching so far down as the latter, may often be seen as a faint yellowish gray line, from the extremity of which a thinner line runs backward and upward. This latter is the posterior crus of the stapes. (These appearances are most frequent in cases of chronic closure of the Eustachian tubes, or when an individual, with a very transparent membrana tympani, swallows several times with the mouth closed and nose stopped. In both cases the air in the tympanum is rarified, and the drum pressed in.)

But the color varies in different parts of the membrane. The gray color is generally darkest in front of the handle of the malleus, and above the triangular light spot, to be soon described, whilst this color is lighter at the posterior half of the membrane. In not a few cases, the upper part of the posterior half appears whitish gray, and is bounded inferiorly by a line running backward from the handle of the malleus. This line is the chorda tympani, and this portion of the membrane is that behind which is placed the supplementary leaf of the membrana tympani.

The gray of the drum becomes mixed with a greater or less amount of red when its mucous membrane, or that of the whole cavity of the tympanum is injected. The membrane appears more or less yellow when there is a secretion of this color in the tympanic cavity. Bubbles of mucus on the inner surface of the membrane can be sometimes very easily seen. In pathological cases the color of the drum undergoes the greatest variations, and we may find all the shades of white, gray, yellow and red.

In the membrana tympani of the child, the covering derived from the integument of the meatus is thicker than in the adult. This is also true of the mucous membrane of the cavity of the tympanum. Hence, as a rule, the ear-drum of the child appears thicker and of a darker gray, and the promontory is but rarely seen through it. In old age, it again becomes duller, less translucent and whiter.

The delicate luster of the outer surface of the membrane depends upon the thinness of the layer of epidermis, so that it is lost so soon as the epidermis becomes thickened, swollen or macerated. This loss of luster, is constant in cadavers where the epidermis of the ear-drum is changed by maceration, in the same manner as in the cornea. In cases where water, oil or other fluid has been poured into the ear, the surface of the membrane then appears more or less dull, the epidermis swollen and sometimes partially detached, as in alcoholic preparations. In some cases, where the ear-drum is drawn strongly inward, its luster is increased and the membrane, as a whole, appears more strongly stretched.

In the normal membrana tympani, in addition to the bright luster extended over its whole surface, there is always one spot where the light is more strongly reflected. This spot is found in the anterior inferior quadrant of the membrane, and has the form of an isosceles triangle. Its base ($1\frac{1}{2}$–2 mm. in length) is nearly at the border of the drum and its apex at the umbo, a little before and below the end of the handle of the malleus. This triangular light spot (with German authors, Lichtkegel, cone of light) may be compared, in its appearance, to the reflection from the cornea. It is so situated as to make an acute angle with the course of the handle of the malleus. This reflexion is usually broader when the ear-drum is pressed outward, and smaller when it is pressed inward by artificial rarefaction of the air in the cavity of the tympanum.

This triangular light spot, is varied in appearance so soon as there is any abnormal change in the surface or curvature of the membrana tympani. This very frequently occurs without any noticeable impairment of hearing, and anomalies of the spot of light, are not unfrequently seen in people who hear well. Sometimes the reflection is longitudinally divided into two parts, or there may be a space between the apex and base when no light is reflected. Sometimes it is contracted to a narrow line, or its apex or base, may be indistinct or wanting, so that finally it may be reduced to a rounded point. Of course this reflection is but weak, or is absent when there is a general loss of luster of the ear-drum from derangement of the delicate transparent cells of epidermis which cover the outer surface of the normal membrana tympani.

Wilde, of Dublin, who first described this reflecting portion of the membrana tympani under the name of "speck of bright light," attributed it to the convexity of the anterior half of the drum. The objection to this view is the fact, that the reflection takes place not only at that part which is convex outward, but also at the umbo, the most concave portion of the drum. The most thorough investigations in regard to the causation of this reflection have been recently made by Politzer.[1] According to this author, the principal cause lies "in the inclination of the membrane to the axis of the auditory canal, in connection with the concavity of the drum, caused by the traction of the handle of the malleus." Politzer used in his experiments a preparation of the auditory apparatus which he had cautiously dried, and from which he had removed the external meatus, leaving the membrane attached to the ring of bone around it. If the preparation were now so turned that other portions of the drum occupied the place formerly held by the spot of light, every one of them showed a reflection of light which varied more or less from the usual spot of light. *Politzer* continues: "What, then, are the conditions under which this reflection of light is effected? If the membrana tympani were a plane surface, and retained

[1] Archiv. für Ohrenheilkunde, I, p. 155, and "Beleuchtungsbilder des Trommelfells," p. 24.

its present inclination to the auditory canal, there would be no reflection to be seen; since, according to the laws of reflection, the light would be thrown toward the anterior and lower wall of the auditory canal. By means of the curvature of the drum, however, portions of the membrane are so changed in position that the light reflected from them is reflected to our eye. One can easily convince himself of the correctness of this opinion by stretching a glistening organic membrane over a large ring, and giving it the inclination of the drum of the ear. If we then examine it with the mirror, as we examined the membrana tympani, we find no reflection; but so soon as the central portion of the membrane is forced inward by pressure or traction, we shall find a reflection occupying a position corresponding to that of the spot of light in the membrana tympani."

Turning to the minute anatomy, the histology of the membrana tympani, we find that the membrane consists of three layers, viz.: a middle, fibrous layer (lamina propria or fibrosa membranæ tympani), and the coverings which this receives, on its outer surface from the integument of of the meatus, and on its inner surface from the mucous membrane of the cavity of the tympanum.

The outer covering of the membrana tympani consists not only of epidermis, but also of elements of the cutis, derived from the integument of the meatus. These elements are found over the whole membrane, so that the connective tissue beneath the epidermis is continuous with the connective tissue of the cutis of the external meatus. These cutis elements are, however, shown to be most abundant at the upper part of the membrane, where quite a strong bundle proceeds from the wall of the meatus to the ear-drum. A close examination shows that this consists of connective tissue with many elastic fibers, of several vessels, and of a comparatively large nerve twig. This bundle descends along the handle of the malleus to the umbo, whence it spreads out in a radiate direction. The more complicated elements of the cutis, as also pap-

illæ and glands, are wholly absent in the outer covering of the membrana tympani. This covering is found at its greatest degree of development in children.

In the cadaver, the epidermis of the membrana tympani may generally be removed in uninterrupted connection, and, after prolonged maceration, we can frequently take it away with the cuticle of the meatus; the two together forming a tube, closed at one end. This layer consists of several laminæ of epidermoidal elements; the outer elements resembling irregular corneal plates, the inner ones being polyonal, nucleated cells. In children, we frequently find this layer of abnormal thickness; and under the hard, external portion, several layers of cylindrical, or fusiform cells, corresponding to the epidermoidal structure of earlier date. The above mentioned bundle which conveys the vessels, nerves and cutis elements, for the most part, to the surface of the drum may be followed for some distance along the upper wall of the meatus. It was formerly described as the musculus laxator tympani minor, and is still sometimes called the ligamentum mallei externum.

The inner covering, a continuation of the mucous membrane of the cavity of the tympanum, consists usually of a simple or manifold layer of non-vibratile tesselated epithelium, beneath which there is a very thin layer of cellular tissue at the extreme border only of the membrana tympani. This mucous lining in the normal state is of extreme thinness, but it is very frequently subject to pathological changes, and then is often considerably thickened. In the ·ripheral portion of this layer of mucous membrane ch' observed a considerable number of "peculiar pro- ns," which may be regarded either as papillæ or as villi.

'ese projections are found "in the outer third of the lower, and uter two-thirds of the upper half of the membrana tympani."

ecopische Studien aus dem Gebiete der menschlichen Morphologie," Erlangen, ·ith illustrations of these villi in Tab. VIII. In regard to the histology of the lso Toynbee, Philos. Transactions, 1851, I, p. 159, and v. Tröltsch, in the ssensch. Zoologie, 1857, B. IX, S. 91. Also *J. Gruber and Prussak.*

Some of them are spherical, like the sponge-shaped papillæ of the tongue; some are simply finger shaped prolongations of the mucous membrane, like the villi of the intestines. The first reach a very considerable size, and, with good illumination, can be seen with the naked eye. Their diameter is from 0.10 to 0.12‴, and their length 0.12 to 0.14‴. The finger shaped projections are smaller; 0.10 to 0.12‴ long, and 0.06 to 0.08‴ broad."

"The central portion of these projections consists of common connective tissue, containing one or more capillary loops. In the periphery of the projections this connective tissue appears more homogeneous and, like the mucous membrane, is covered with several layers of flattened epithelial cells. I have looked in vain for nerve fibers in these structures, and am therefore inclined to class them with the villi rather than with the papillæ. This view is also favored by the fact that some of them are connected with the mucous membrane by pedicles." *Gerlach.*

The middle, fibrous layer, the *lamina propria*, of the membrana tympani, consists of fibers peculiar to itself, partly radiating, partly circular, yet so arranged that they form two easily separable layers, each of which contains fibers of only one direction.

The outer of these layers (the layer of radiating fibers) consists of fibers which run from the cartilaginous ring to the handle of the malleus; the fibers of the lower half having their center in the scoop-shaped end of the handle of the malleus, whilst the other fibers are attached to its anterior ridge.

The radiate character of this layer is not effected by a direct radiate arrangement of its individual fibers, as would be inferred by an examination by a low power; but their resultant is radiating, by the crossing of fibers which come obliquely from the two sides. This arrangement of the fibers makes the highly magnified image appear somewhat rhombic.

The inner layer (layer of circular fibers) consists of concentrically arranged circular fibers, which are wanting in

the extreme periphery, are most abundant just inside the periphery, and thence gradually decrease in number toward the center. When these circular fibers are most strongly developed they form a pretty well defined ring; the thickness of this layer, according to Gerlach, being twice as great as that of the radiating fibers. This layer of circular fibers is very intimately connected with the mucous membrane; the nutrition of the former being dependent upon the latter.

We can often see this double direction of these fibers with the naked eye, by holding the membrana tympani between the eye and the window. With a microscope of low power this can be seen more easily. To demonstrate the two fibrous layers, it is best to manipulate the preparation under water with the aid of two forceps. It is evident that the membrane is materially strengthened by this arrangement of its fibers.

The handle of the malleus lies between these two layers, or rather the one proceeds from it, and the other lies behind it; but in such a way, that the upper portion of the ring of circular fibers runs along the anterior side of the neck of the malleus.

Joseph Gruber and *Prussak* have recently made some thorough investigations as to the relations of the handle and short process of the malleus to the membrana tympani, which have given us some new points of view of this important question.

Gruber first called attention to a cartilaginous structure, beginning above the short process, and running along the handle of the malleus, and has recently described it in his monograph on the membrana tympani. (The plates of the membrana tympani, on pages 28 and 30, are from this work. St. J. R.)

Gruber states that there is a complete articulation between this cartilaginous structure and the malleus; that they are separated by an epithelial layer, and that there is synovial fluid between them.

Prussak, on the contrary, denies that there is any separation between this cartilage and the malleus. He states that there is not

only a coating from the cartilage to the short process and the malleus, but that the cartilage enters into the substance of the malleus. Thus the cartilage forms another portion, and not unfrequently one-half of the whole size of the short process. On the handle, also on section, cartilage cells were found not only in the periphery but in the interior. According to *Prussak*, only the membrana flaccida lies in front of the neck of the malleus, in which there are no decided fibers. The circular fibrous layer surrounds the lower third of the malleus on all sides; so that it lies, as it were, buried in this layer. The higher up we make the section, the greater will be the amount of circular fibers formed on the outer surface of the malleus, and the less of them on the inner side. The circular fibrous layer thus plays the part of periosteum and of perichondrium for the handle and short process of the malleus.

According to Gerlach, the layer of radiating fibers spring, for the most part, from the annulus tendineus. The layer of circular fibers, on the contrary, begins in the peripheral portion of the ear-drum.

Both portions of the fibrous layer of the membrana tympani consist of sharply defined, ribbon shaped, homogeneous fibers of high refractive power, and of peculiar kind. Between them, in regular arrangement, lie fusiform, nucleated cells, provided with several processes and corpuscles of cellular tissue, which, in the two layers, are differently arranged, both in respect to the position of the corpuscle and the direction of the processes. Microscopic sections of the ear-drum give a fine picture of a tissue traversed by a delicate cellular net, with its ramifications in all directions. This appearance is even more beautiful than that which we observe in sections of tendons or of the cornea.

In the newly born, these fibers are much narrower, and resemble curled connective tissue, since they are less highly refractive than in the adult. The interstitial cells appear in extraordinary abundance on the addition of acetic acid.

The membrana tympani histologically bears a great resemblanee to the cornea; and many of the descriptions and drawings of ulcerations and other pathological conditions of the cornea, as *His* and

others give them, often correspond to the appearance under the microscope of similar changes in the membrana tympani.

In sections of the membrana tympani of the child, which are the most serviceable in studying the cellular constituents of the lamina fibrosa, I several times found a constant relation between the corpuscles of cellular tissue and the epithelium, so that it appeared as if the epithelium of the inner surface of the ear-drum sent processes into the proper tissue, or as if the ramifications of the corpuscles of cellular tissue stood in direct connection with the epithelial cells.

In regard to the perfectly homogeneous connective tissue, which makes up the fibrous layer, Gerlach says: "It holds an intermediate position between the fibrillated and the homogeneous connective tissue of Reichert. Perhaps its study will most readily bring the much talked of connective tissue question to a solution. Not the slightest trace of fibrils, which would characterize them as bundles of connective tissue, can be demonstrated in these fibers."

Vessels of the Membrana Tympani.—This membrane possesses two sets of vessels, coming from distinct sources and, according to Gerlach, having no connection with each other, except at the periphery by capillary anastomoses. The external vessels are found in the layer of cutis, that connective tissue which lies between the deep cells of the epidermis and the layer of radiating fibers. The inner vessels lie in the mucous membrane of the membrane, the fibrous layer being wholly destitute of vessels.

The external vascular net work of the ear-drum arises from the vessels of the cutis of the meatus (these arising from the art. auricularis profunda of the maxillaris int.). The vessels of the cutis are continued to the surface of the drum in the same manner as from the cutis itself, as described above.

This occurs on the whole circumference of the membrana tympani, where they form a fine centripetal circle of vessels, which are generally found injected with the adja-

cent deepest part of the auditory canal. These little vessels are nevertheless quite fine, and their injection is more rarely observed. Some larger vessels extend themselves from the upper wall of the auditory canal upon the membrana tympani, and these run immediately above the handle of the malleus, or a little behind it, to the umbo, to the middle of the membrane, whence they finally branch off in a radiate direction towards the edge; and in that place unite with the peripheric vascular net work. These larger vessels are very frequently filled with blood on the dead body as well as in the living subject. Their vascularity appears under our very eyes, if we inject warm water in the auditory canal, or if the patient inflates the membrana tympani. Not unfrequently they fill up with blood of themselves, from an examination with the speculum, which has been continued a long time, or which has been often repeated.

The inner vascular net work of the membrana tympani, running in the mucous membrane, arises from the vessels of the tympanic cavity, but is smaller than the outer vessels, which have a superficial course. It is very difficult to preserve successful artificial injections of the membrana tympani.[1] However, we frequently find on the dead body, especially on dead bodies of children, very instructive natural injections of the larger vessels of the one or of the other part. We may also convince ourselves very easily on the living subject, that the chief vessels of the tympanum, which run superficially along the handle of the malleus, proceed from without, that is, from the upper wall of the auditory canal.

Nerves.—As the cutis is the most vascular part of the membrane, so the nerves are chiefly or wholly found in this structure. Quite a large nerve trunk branches out on

[1] Such an one is described in Rüdinger's Atlas (München, 1866), Table IX.

it. This tympanic nerve, exactly like the principal vessels, passes from the integument of the upper part of the wall of the auditory canal, over upon the membrana tympani. At the short process of the malleus, little branches are given off, which run along the handle of the malleus somewhat above or behind it, very superficially, up to the extremity of the long process or handle. We may still often follow it, in fine twigs under the handle of the malleus.

This tympanic nerve is a branch of the superficial temporal nerve, or the auriculo temporal, a sensory branch of the third branch of the 5th, and causes the very great sensitiveness of the outer surface of the membrana tympani. I once found a nerve twig passing from the auditory canal upon the lower and posterior part of the membrana tympani. I have never been able to find nerve filaments, either in the fibrous or mucous layer of the drum. *Gerlach* has observed fine nerve fibers, without medulla, in the latter. At any rate, the mucous layer has very few nerves, while the cuticular layer has very many, and is very sensitive.

This fact coincides with the practical experience, that superficial inflammations of the membrana tympani are always very painful, while the greatest changes may take place in the mucous layer without the patient ever having any pain in the ear.

We may easily convince ourselves of the just described course of the tympanic nerve, by separating the integument of the osseous portion of the auditory canal, and then dissecting up in connection with it, the outer layer of the membrana tympani, and treating it with a solution of soda. The principal branch is so large, however, that we may frequently follow it with the naked eye, or a magnifying glass, some distance on the outer side of the membrana tympani.

The chorda tympani nerve, although it runs on the inner surface of the membrana tympani, gives off no branches to it.

LECTURE IV.

DISEASES OF THE AURICLE.

Contusions; othatomata; incised and other wounds; tumors; acute and chronic eczema; the auricle in the gouty diathesis; malformations.

GENTLEMEN: In beginning to-day, to speak of the diseases of the outer division of the ear, we have first to describe the affections of the auricle. This description need not, however, consume much time, since the auricle is comparatively seldom alone affected; and when it participates in affections of the surrounding parts, there are usually no very peculiar symptoms.

Injuries of the auricle not unfrequently occur, on account of its exposed position on the side of the head. The most frequent are contusions from a blow or a fall. If, on the receipt of such injuries, the skin be not at the same time divided, the blood becomes extravasated between the integument and the cartilage on the concave surface of the auricle, and fills up its depressions, or causes the previously sinuous portions to appear as roundish elevations or swellings. Such tumors, which are usually of a bluish red appearance, having a doughy feel, exhibit in recent cases an increase of temperature, and are generally developed in the upper half of the auricle, whose whole appearance is completely changed by the extravasation of the blood. If the cartilage itself has been affected by the injury, or if complete resorption of the extravasated blood has not

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occurred, characteristic changes in the shape of the part are apt to remain. In consequence of the thickening of the soft parts, and subsequent cicatritial contraction, the long and short diameter of the auricle become somewhat shortened, and more curved in some parts, while in others it is folded together, causing an obliteration of the different normal depressions and elevations, so that the part assumes a peculiar, as it were, a shrunken or shriveled appearance. This deformity, which occurs most frequently on the upper part of the auricle, may be sometimes observed on the ears of boxers, and also as a plastic ornament on antique statues of pugilists and gladiators, as well as on those of the deities, such as Hercules and Pollux, who were renowned for their fighting powers.

Othatomata.—The vascular tumor of the ear, occurring in the insane (othatoma), is quite similar in appearance and course to the form first spoken of, arising from extravasation of blood caused by contusion. Most of the modern physicians for the insane, believe that these othatomata have a mechanical and traumatic origin, and that they are not peculiar to the insane. They are found very frequently in the ears of the insane, and especially of maniacs and paralytics, because these injure themselves much more frequently than the other classes, and are much exposed to injury from their surroundings. *Gudden* has been the most exact observer as to this point.

Virchow[1] and *Ludw. Meyer*[2] have recently shown, that even after very considerable injuries to the ear, no such tumors occur, and that they appear in cases where it can be proven that only a slight stretching of the auricle has occurred. A normal auricle is said to have great capability of resisting injuries of any sort. We must hence believe, where rupture of the cartilage and blood extrava-

[1] Die Krankhaften Geschwulste I, Berlin, 1863, S. 135.
[2] Virchow's Archiv., XXXIII, S. 457.

sations have occurred, that there is some morbid property in the tissue of the part. *Virchow* speaks of old softening processes as such predisposing causes. *L. Meyer* speaks of enchondromatous degeneration and tissue proliferation of the auricle, by which alteration of structure occurs, and the elasticity of the part is diminished, and thus the occurrence of extravasations and ruptures is considerably favored. Such tumors of the auricle, having in part bloody and in part albuminous contents, have been observed in cases where no mechanical force has been applied to the ear; a fact which speaks for the correctness of the idea of Virchow.[1]

It is very natural, however, that very frequent and violent maltreatment of the ears, for example, such as occurred to ancient as well as modern pugilists, should gradually produce such a degeneration of the cartilaginous tissue, as will finally lead to its rupture and to hemorrhages.

There are also very different views as to the treatment of othatomata. Some authors advise the evacuation of the effused blood by extensive incisions; while others assert, that after such incisions the tumor fills up again rapidly, and thus retards the healing, and that the deformity remaining will be greater than if the matter has been left to itself. Others recommend the insertion of setons.

Wounds.—There is nothing of especial interest in wounds of the auricle. I only mention them here, because, as is well known, they are among the more frequent of the affections of students. (In allusion to the results of student's duels, so common in some German universities.)

On account of the irregularity of the surface of the wounded part, which renders it rarely possible to use adhesive plaster, the cut surfaces must be united by suture. Auricles which have been entirely divided will heal again. In India, where, as is well known, the ears are sometimes

[1] Chimani, Archiv. für Ohrenheilkunde II, S. 169, Schwartze, ibid., S. 213.

cut off in war, and as a punishment for crime, they are said to be sometimes replaced by a transplantation from a living person. With us, artificial ears are usually made a substitute for those which are lost. The hearing power does not appear to suffer markedly from loss of the auricle, as many observations have shown.

Tumors.—Among the tumors which occur on the auricle, there are, besides the various sorts of sebaceous tumors, and an unfrequently observed hypertrophy of the auricle, roundish growths with hard fibers, which sometimes occur as "a punishment for the barbarous custom of wearing ear rings." They develop from an improperly treated puncture of the lobe of the ear, attain a considerable size, and should be removed with the knife.

These slowly growing fibroid tumors of the auricle are said to be very common among the negroes of the Antilles. [They are not uncommon in New York, especially among the colored females, although I have removed several from whites. Brass ear rings have generally been worn when these growths occur. A V shaped incision, including the tumor, made with strong scissors, is the best method for their removal, and one which enables us to restore the normal appearance of the lobe to a surprising extent. St. J. R.] Erectile and other vascular tumors have been observed on the auricle, and have been removed. Epithelial cancer of the auricle also occurs not unfrequently.

Eczema.—It is not unfrequently observed that acute and chronic eruptions of the integument, of the most diverse character, are continued from the neighboring parts upon the auricle. Eczema of the auricle is one of the most common of the affections of the skin, which thus localize themselves.[1]

[1] A very extended account of this affection are to be found in Archiv. für Ohrenheilkunde I, S. 133, by H. Auspitz.

The disease is in general characterized by the same peculiarities as those seen in eczema of other parts of the body. Yet there are always some variations in the course and symptoms, which are due to the peculiar structure and the properties of the auricle.

Eczema appears on the ear either in an acute or chronic form. Acute eczema is chiefly indicated by a great redness and edematous swelling of the skin, so that the auricle generally stands out quite prominently from the head. There are numerous vesicles arranged closely together, which burst at intervals and throw out an abundant reddish colored fluid, which runs down over the lobe of the ear. In the very severe forms, we are not able to distinguish individual elevations of the epidermis, with serous contents, but we find the surface greatly reddened and infiltrated with a consistent fluid. The subjective symptoms, united to these objective ones, are a sensation of great heat in the part, and painful tension, occasionally accompanied by febrile excitement.

Eczema of the ear is more frequently observed as a chronic disease. We then have either the impetiginous form, when the fluid, exuded in various points, dries up quickly and thus causes the formation of yellow or yellowish brown crusts, or an abundant development of epidermis on a reddish base occurs, in conjunction with some moist spots. [*Eczema squamosum.*]—In this latter form especially, in consequence of the scratching of the patient, occur excoriations and deep slit like fissures, *rhagades*, upon which the epidermis is destroyed, and between whose red edges an abundant fluid generally exudes.

Chronic Eczema.—This is most frequently seen in connection with eczema or seborrhœa of the scalp. The whole integument of the ear takes part in some way in the inflammation or only individual parts may be affected.

Thus, at times, only one fissure is formed on the posterior surface where the auricle is united to the mastoid process, or there is a denuded portion, surrounded by small crusts, in the depression behind the helix. In other cases, the lobe alone is of reddish color, moist, or covered with scales; and then the eczema always starts from the perforation that is made for the insertion of an ear ring, in case such exists.

Eczema appears to occur most frequently in children, and females in the climacteric periods, puberty, and cessation of the menses. It is then often very obstinate, and frequently relapses. On account of the severe itching and burning sensations, and the long duration of the disease, which may be for years, and the fact that it causes a deformity of the auricle, it may become a very unpleasant affection. The auricle, naturally a beautiful part of the body, becomes an unelastic, unpleasant looking part of the integument, having a thickened and brownish red, dirty appearance, losing all the elevations and depressions by which it is normally distinguished, and is also covered by crusts, and scabs, and fissures, in which bleeding is very readily excited. When the external auditory canal participates in the morbid process, its caliber may be lessened or occluded, and thus deafness may be produced.

Acute eczema, in its incipient stages, at least, may be confounded with erysipelas. A congestive seborrhœa of the outer ear may be sometimes considered as a chronic, scaly eczema. In seborrhœa, however, the swelling and infiltration is absent, and there is no moistness in the part. There is also a fatty feel to the structure, and a slight amount of itching.

Prognosis.—In speaking of the prognosis, I should, first of all, call your attention to the fact, that relapses are very common in acute eczema of the ear; and that in the chronic form, it generally requires great patience and long

continued treatment before a favorable termination is reached.

Treatment.—In the treatment, we should not keep the head or ear too much wrapped up. We should confine ourselves to keeping away the external air. The best mode of accomplishing this is by sprinkling the parts with starch or rice meal. Warm fomentations with astringent solutions, especially a dilute one of acetate of lead, generally shorten the acute stage, and lessen the itching or burning sensations. The use of fats and oils is especially adapted for the chronic and the impetiginous forms. In employing them, we should take care that all the crusts are kept for sufficient time in contact with the ointments. I generally cause the patient, after the ear has been smeared with the substance used, to wear at night a little covering for the ear, made of soft leather, or strong linen; and in the morning the crusts and scabs thus softened may be washed off. Immediately after the part has thus been cleansed, astringent applications are made for a time, and the ear then strewn over with the powdered material before mentioned. If this be not done the hair of the patient will adhere to the excoriated moist surface.

It seems to be a matter of indifference as to what kind kind of oil or salve is used. Their chief action consists in softening the dried secretion, in order that they may be easily detached and removed. The simple diachylon plaster, equal parts with olive oil, is particularly recommended, besides ointments of oxide of zinc, of white precipitate, or of iodureted sulphur. In the squamous eczema, which is particularly obstinate, the daily use of a preparation of tar upon the part, e. g., birch tar (*oc. rusci s. betulæ*), or a coating of collodion is particularly useful. It is very important, at the same time, to treat the integument of the neighboring parts, particularly of the head, if this is at the same time affected with eczema or seborrhœa, because the

affection of the auricle is very frequently maintained by such conditions of the neighboring parts. We should also learn if the patient is in the habit of using irritating pomades, hair ointments, or the like. When the irruption is very extensive, a cold shower bath applied to the parts daily, is very beneficial. We should then protect the ear from the entrance of cold water.

The Auricle in Gout.—An attack of gout is sometimes announced by a slight inflammatory and painful redness on the upper part of the auricle, while in persons with an arthritic diathesis, depositions of urates are quite often found in the auricle.

Garrod[1] has recently called attention to the frequent occasion of uric acid depositions in the auricle, in the case of individuals with the arthritic diathesis. According to him, these arthritic deposits were the most frequent of all the external symptoms of this sort, and they therefore are of some importance in the diagnosis of gout. Among seventeen patients with gout, in whom the deposits of urate of soda were found, *Garrod* found them on the ear nine times, and at the same time in the vicinity of the joints; seven times on the auricle alone; and of all the cases where they existed in the joints, there was only one in which they could not also be found in one of the ears. They were most frequently found on the upper portion of the border of the helix. They have not yet been observed on the lower third of the auricle. Their size varies from that of the head of a pin to that of a pea. They are said to be formed most frequently after an attack of gout, and generally without any local symptoms.

Occasionally there is a slight pain or pricking sensation felt in them before the attack. *Charcot*[2] confirmed these

[1] The Nature and Treatment of Gout, London, 1859.
[2] Gazette med. de Paris, 1860, p. 487.

observations before the *Société de Biologie*, and enlarged upon them in some respects.

I would here like to call attention to the fact, that not unfrequently in persons who did not appear to be affected at all with gout, and occasionally in those who were very young, I have observed spots in the auricle of varying size, circumscribable, and partially movable in the cartilage, especially on the upper portion of the furrow of the helix. I can give no more exact idea as to their nature; but they feel like partial calcareous or osseous degenerations. *Leuckart* and *Heinrich Müller*[1] have shown that circumscribed spots of calcareous degeneration may occur in the reticulate cartilage of the ear, at least in animals. They might be confounded with the above described deposits of urate of soda, occuring in persons with the arthritic diathesis.

Malformations.—Congenital malformation or deformity of the auricle is by no means unfrequent. Together with this external abnormal condition, there is generally found an imperfect or abnormal condition of the auditory canal, of the cavity of the tympanum, or even of the labyrinth. The auditory canal is not unfrequently completely closed, or even absent. The operative opening of the canal thus naturally closed, would usually be of slight benefit, on account of the affection of deeper parts, not to speak of the very great difficulty of keeping open a canal thus newly formed. Such malformations appear to occur more frequently on one side alone.[2] According to *Virchow*,[3] congenital anomalies of the external ear are most frequently to be referred to imperfect closure of the first branchial fissure, and commonly occur in connection with cervical branchial fistula and cleft palate.

[1] Würzburger Naturwissenschaftliche Zeitschrift, 1 Heft, 1 Band., S. 92, et seq.
[2] Welcker. Archiv. für Ohrenheilkunde, 1, S. 163.
[3] Virchow's Archiv., Band. XXX and XXXII, S. 518.

LECTURE V.

THE EXAMINATION OF THE EXTERNAL AUDITORY CANAL AND MEMBRANA TYMPANI.

Importance of the examination of the external ear in the diagnosis of aural disease, and for science in general; the aural speculum; the illumination with the concave mirror, as compared with the methods formerly employed; historical; the angular forceps.

GENTLEMEN: Before we pass on to the diseases of the more deeply situated parts of the ear, we must look at the means employed in diagnosticating them. We have, then, to consider the methods for the examination of the external auditory canal and the membrana tympani.

It is not possible to form a positive diagnosis in diseases of the ear, without being able to thoroughly examine the auditory canal and membrana tympani.

If it be true in general, that the objective inspection of any organ forms the most important part of an intelligent examination of a patient, it is especially so in the diagnosis of aural affections. There are no cases where we can draw so little evidence from the history of the patient and the subjective symptoms, as in those occurring in aural practice. A furuncle, or an eczema of the external auditory canal, may cause intense pain and profound deafness; a simple plug of wax may excite the most troublesome vertigo, and unbearable *tinnitus aurium*, while, on the other hand, we may often meet with large perforations of the membrana tympani,

and very great changes in the cavity of the tympanum, without complaint from the patient of anything more than of some impairment of hearing.

The membrana tympani forms the partition wall between the auditory canal and cavity of the tympanum, or middle ear; and the inner side of it contains a coating of the mucous membrane of the middle ear, and thus takes part in all the diseases of the cavity. The color and reflection of this membrane, its inclination to the auditory canal, and its curvature are considerably influenced by the condition of the parts behind it, especially by that of the cavity of the tympanum, and of the Eustachian tube. The appearance of the membrana tympani differs therefore, according as the cavity of the tympanum and its mucous membrane is in a normal or abnormal condition; according as the Eustachian tube is permeable or closed.

The examination of the auditory canal, and especially of the membrana tympani, is therefore the most important means of diagnosis, and is consequently first undertaken in our objective examination of a patient. If I now say to you, that in accordance with my experience, the greater number of surgeons are not in a position to appreciate what is to be seen in the outer ear, much less to critically examine it, you will fully understand the peculiarity of the ethical and scientific condition in which the practice of aural surgery was at one time, and in which it still to some extent continues.

It is an undeniable fact, that the greater number of practitioners cannot examine the ear at all, and a secret is scarcely made of such ignorance. This fact is of vast importance. All the evils from which the aural surgery of the present day suffers, may be traced back to this. Whoever does not know how to examine the ear, should not attempt a diagnosis of its affections. If he does not

know what is the matter with the patient, he has no conception of what is to be done for the disease. Each attempt at treatment, without an examination, must remain a very vague one, and, as a rule, have no result, unless some happy accident accomplishes something for the patient.

The slight estimation in which aural surgery is held by so many of the physicians, as well as by the laity, also depends to some extent on these circumstances. It is an old psychological, and very easily understood fact, that we practise willingly, and highly esteem what we understand, and feel ourselves certain in; and on the other hand, what we imperfectly understand, and we do not like, we, if possible, push aside and neglect.

Some pains-taking physicians have confessed, that it annoys them very much when a patient with disease of the ear comes to them, for they cannot examine him properly, and they are ashamed to attempt to do anything for a patient without knowing what his disease is. Almost every physician is glad when he has got rid of an ear patient in any way.

The reason that physicians in general so little esteem the treatment of diseases of the ear, and assert this so openly at each opportunity, is because they think in this manner to be able to soften and conceal, before the world and themselves, the sense of their own want of knowledge. Very naturally, the very poor prospect for aid from physicians, was long since known to the laity. Never do patients seek a physician so late as in aural diseases, and never do they so commonly consult advertised books and try quack remedies. Patients feel themselves without help from the side where in other cases they find it; therefore, quackery has a fair field.

Since, then, the profession have so little of an independent judgment on the subject of aural disease, windy and superficial cabblings have been palmed off as the results of

scientific labor, even up to the latest period, and medical phantasies and nonsense, have been permitted to be woven into the whole subject.

You see, gentlemen, that we always come in a dreary circle again to our starting point, viz., the fact that the vast proportion of the profession, up to the present time, have not understood how to examine the ear. In this fact we shall find the most satisfactory reason that the knowledge of aural diseases stands to-day, much less developed than other departments of medicine, and that their scientific investigation was so lately undertaken.

What, then, is the ground of this improper position? Is the examination of the auditory canal and membrana tympani so particularly difficult, or were the previous methods not good, and capable of being generally practised? Undoubtedly it is not in the difficulty, but in the method. That the previous modes of examination are not good and practical in the full sense of the word, is sufficiently proved, from the fact that even now so few physicians can examine the ear. A really good method would have long since broken the way, and things for years past, would have stood in a different position from that in which they unfortunately now do. The fact, that a great number of easily distinguished and very common changes and abnormal appearances in this membrane, concerning which we shall speak more fully, have been entirely unperceived by aurists, speaks still more for the defects of the previous methods.

Let us now turn directly to the subject. Without any assisting means, we can see only the opening of the auditory canal. If we press the tragus a little forward, while at the same time we draw the auricle backward, we widen the entrance, and we are able to examine the first part of the passage. We are not able, in this manner, to look any deeper unless the canal is abnormally

wide, which is sometimes the case. Generally, the auditory canal is too narrow to allow sufficient light to fall upon the deeper part, and upon the membrana tympani; the canal does not run in a straight line, but it has an angular curvature in its course, and there are also little hairs which grow from the side of the osseous part, encroaching upon the caliber. If we wish to see the membrana tympani, which is the deepest lying part, perfectly and exactly, we must remove all these hindrances; in a word, we must sufficiently illuminate the back ground, change the crooked course of the canal to a straight one, and finally, push the little hairs to one side.

All these requirements we may attain in the simplest and best way, if we place a small tube in the passage, an aural speculum, and throw the day light through it upon the parts, by means of a concave mirror. These tubular specula, which have no opening at the side, are to be preferred to Itard's or Kramer's ear specula, still much used in Germany. These latter are much larger and clumsier, not so convenient or easily adapted to their purpose. Generally speaking, all the widening of the bony canal that is necessary, may be accomplished by the coniform specula, and we have no need for a dilator. Such an instrument, if pressed open while in the ear, often causes pain. The value of this valvular speculum is also often somewhat lessened, because the little hairs and the epidermis are apt to protrude through the sides, and obstruct the view. We are obliged to hold the valvular and handled speculum as long as the examination lasts, while specula of the other kind, of the proper size, and properly placed, generally remain in position, while the hand is free for other manipulation.

Kramer's ear speculum has therefore no advantages over the much smaller and handier tubular speculum; but, on the contrary, the disadvantages attached to its use are

considerable. The ear specula which I use are silver, cylindrical tubes, having a funnel shaped outer surface. We may generally employ three, each of different caliber, to be used according to the width of the canal undergoing examination. These tubes are placed in each other, and may be conveniently carried in any vest pocket.

Fig. 5.

The cut represents the exact size of the instruments. They should be thin, the metal evenly worked, and the smaller opening rounded off, in order not to injure the auditory canal by their introduction. It is of scarcely any importance, when the method of illumination by means of the concave mirror is practised, whether the interior of the speculum is polished or is black.

(I use the aural speculum, introduced by Sir Wm. Wilde, but first employed by Gruber, the elder, of Vienna. It is a simple conical tube. St. J. R.)

When we wish to use these specula we draw the auricle somewhat backward and upward, and thus overcome the curvature of the auditory passage. We then introduce the speculum with a slight rotary motion of the other hand, without using any force whatever. If the instrument be now introduced, the second hand becomes superfluous, and the thumb of the same hand which holds the upper portion of the auricle by the index and middle finger, presses upon the lower border of the outer opening of the speculum. In this way, the tube and canal are kept in the same direction, and may both be changed to different directions, in order to bring the membrana tympani and the different parts of the auditory canal, on all sides, into the field of vision. Beginners are apt to leave the ear to itself, and hold the speculum alone. In this manner, we may easily press against the auditory canal, occasion pain, and pre-

vent the full mobility of the speculum. If we draw the speculum slowly out, after we have made the examination of the drum, we can see each individual part of the canal exactly.

Of greater importance is the question, how can we best illuminate the auditory canal and membrana tympani? The valvular speculum is less convenient than the tubular one, which I have described, yet we can examine the ear well and thoroughly with it, even if it be a little troublesome. It is not so, however, with the former methods of illuminating the ear. They have proved themselves to be wholly insufficient.

Until recently, we have been in the habit of using only sun-light or bright day-light, falling through a window into the auditory canal. This method is very deficient in many respects. We can only employ it under certain circumstances; we cannot see with sufficient distinctness with it. It is also very inconvenient.

We may learn from our daily experience with sun-light illumination, that it is a great deal too glaring and blinding, to serve as a means of direct illumination where small and indistinct changes of form and color exist. It is an optical fact that direct sun-light, in general, is not so good for use as interrupted and diffused light. Certainly, in every day life we never expose an object, from which we wish to bring out delicate tints of color or minute elevations on the surface, to the direct sun-light; such objects, for instance, as a picture, or a piece of ivory carving.

We could examine the ear better with simple direct day-light, than with sun-light, if there were not a number of objections connected with its employment, and if a number of favorable circumstances, working with us to secure the desired end, were not required. If we wish to make use of day-light, in examining a patient, he should be brought to the window. Bedridden patients in most cases object

to such a removal. The window must be free from curtains, blinds, etc. If it do not look on the open sky, or be not opposite a house on which the sun shines, the light will not be sufficient to illuminate the deeply lying parts of the ear. The position of the surgeon is also a very bad one in this method of examination. He must stand between the light and the patient, and thus he easily makes a shadow with his head. This will more commonly occur when the surgeon is not far sighted. Indeed. if the surgeon has had but little practice in examining the ear, the formation of a shadow with the head is very troublesome, precluding, as it does, the possibility of seeing the drum of the ear.

For the foregoing reasons, the head of the surgeon cannot be very near the ear. Hence, minute changes, especially in the membrana tympani, may pass unnoticed even to the sharp sighted; thus the method must always be limited to making out coarse distinctions. In order to be able to see small objects, the distance of the eye from them cannot exceed a certain amount, or retinal images occur which are too small to form an isolated impression. More than all, we cannot always have bright day-light at our service. In a climate so rich in clouds and rain as that of Germany and England, we must often wait weeks to find day-light enough to make an examination of the ear. This last fact demands the introduction of another method, or one that does not depend upon weather. For how can we speak of a progressive, exact, estimation and examination of a single case, if we cannot daily, and at any hour in the day, have at hand and employ the means of such an examination?

This great deficiency—the dependence of the illumination and examination upon the weather, and the kindness of the skies—was naturally felt long ago; and it was attempted to help the matter by means of an apparatus which would always furnish a source of light. The first attempts, except the proposition of *Fabricius ab Aquapendente* (1600),

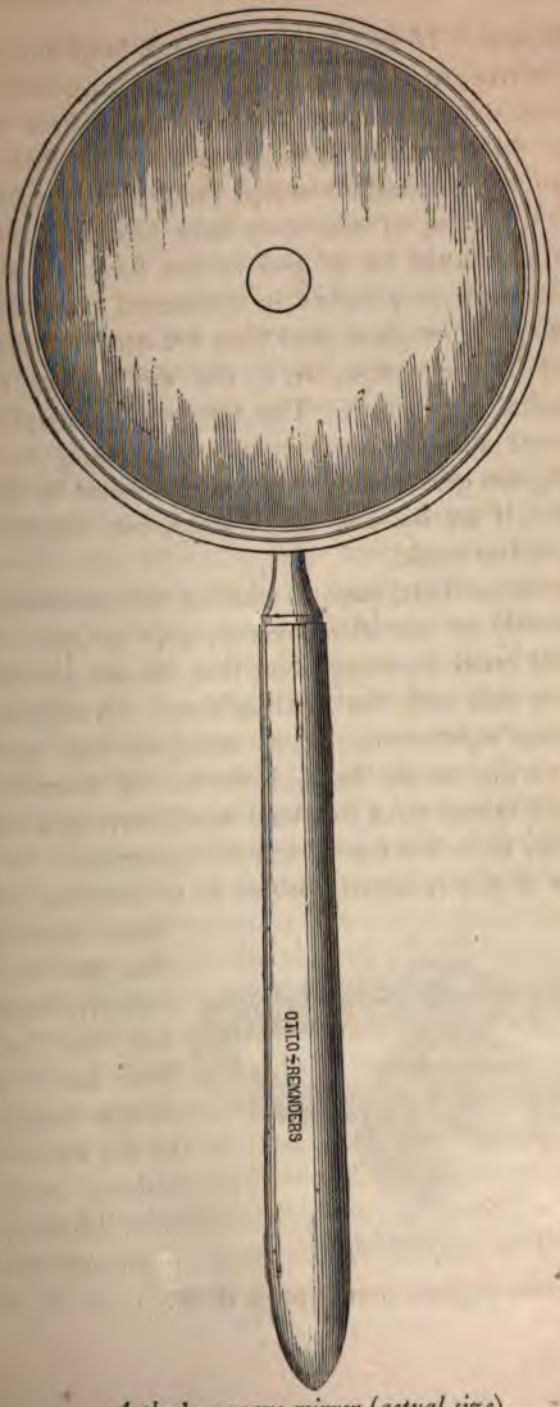
to place a light behind a flask of water, and throw the concentrated rays into the ear, were made in the middle of the last century by an English army surgeon, *Archibald Cleland.* The surgeon held in his hand a convex lens of three inches focal distance, and the center of which was opposite a wax light, so placed that the united rays of light were thrown through the lens into the auditory canal.

All the different sorts of illuminating apparatus which have been produced since this, are no very great improvement on Cleland's, which was a very great advance on previous methods. Instead of the convex lens, a concave one is used; instead of wax light, gas, oil, etc. Some of them are enclosed in a case, have a tube attached, etc. Some of these contrivances are very clumsy and complicated. Many of them which have been suggested, even very recently, are perhaps considered of more value by their inventors than by the profession in general. All of them have attained some celebrity, and a few, consisting essentially of an artificial source of light and a concave mirror, are still constantly used by some aural surgeons.

To all of these methods there is the objection, that we obtain artificial, colored light, which adds something foreign to the natural color of the parts, so that the actual properties and color are not quite correctly estimated. Some of these appliances dazzle the examiner by the power and nearness of the light, which stands exactly opposite the eye of the surgeon. In the use of some of them, there is also danger of setting the hair on fire, especially if it does not lie very smoothly on the head. These means of examination have never acquired any reputation among general practitioners, and are scarcely to be found, except in the consulting rooms of specialists.

But it is not necessary to have any artificial light, or complicated contrivances, in order to always obtain an illumination of the canal and membrane, which is more

Fig. 6.



Author's concave mirror (actual size).

than sufficient. If we take a sufficiently large and powerful concave mirror, and by means of it throw a powerful stream of ordinary day-light upon the ear, we can see the parts clearly in the minutest detail, as is only possible with the naked eye. This method sweeps away all the evils attending the other ones, of which we have just been speaking. The mirror should be of 5–6 inches focal distance, and not less than 2½ to 3 inches in diameter. Metal mirrors are not so good as glass, and they are most convenient if perforated in the center, or if the quicksilver covering is removed at this point. The mirror of the ophthalmoscope is not adapted for this purpose, being too small, and having too great a focal distance. Hence its illuminating power, if we do not use a lamp, but simply diffuse daylight, is too weak.

Coarse distinctions, such as whether the membrana tympani is wholly or partially covered, grey or red in color, whether the canal be stopped or free, we can generally ascertain very well with the small mirror. In certain cases, e. g., during operations, or in watching the membrana tympani during an air bath, I fasten the mirror to the forehead by means of a forehead band, having a ball and socket joint, as in the use of the laryngoscope.

The use of the reflector enables us to turn the ear away from the window, the patient being between the window and the surgeon. We can examine adults most easily in the standing position; in the case of children the surgeon may sit down, while the little patient stands on a stool.

Fig. 7.

Translator's forehead band.

Experience teaches us, that this method of examination answers all requirements, and that its advantages in opposition to those formerly practised are very great. The colorings of the part are not changed, as occurs in the use of artificial light; but they are distinctly and truly reflected. The concave mirror is a simple appliance. It is not costly, and is portable. The greatest advantage of this method of illumination, however, is that it may be practised in all kinds of weather. It may also be used in case the patient lies in bed, a candle or lamp being employed if necessary; and we are not even obliged to turn the patient to a window if a light colored wall be near.

Furthermore, the examination of the ear in this manner is easy and convenient. There is no danger of making a shadow with the head, and we can get very near to the patient, and see clearly the smallest and finest distinctions in form and color, which even the sharpest eye could not distinguish when removed at any distance. It is by no means difficult to learn this method of examination; and since it has become known it has become very widely adopted.

(It is convenient to have a revolving chair in the consulting room, so that the patient is not obliged to rise, when the examiner turns from one ear to the other. The author's method of illuminating the auditory canal and membrana tympani, was introduced by myself into the New York Eye and Ear Infirmary in 1863. It soon superseded all other methods of examination in that institution, was afterwards introduced by my friend, Dr. *H. L. Shaw* of Boston, into the practice of the infirmary of that city, and, if one may judge from the large number sold by the instrument makers of this city, has gone into very general use. My experience confirms all that Professor Tröltsch claims for it; and it is believed that we have nothing more to desire in the way of a method of examining the external parts of the ear. St. J. R.)

The first forceps shaped "speculum auris" is pictured in the works of Fabricius Hildanus (Fabry, from Hilden, a place near Düsseldorf), in 1646. These dilating ear specula have not been much changed or improved since then. There are also many sub varieties of the tubular ear specula, of which one is about as useful as the other, and which are all better than the dilators. The one described by the elder *Gruber* of Vienna, more than 30 years ago, has served as a

FIG. 8.

Method of examining the ear.

model for all the subsequent ones. Its outer opening is only 10 mm. wide. The one suggested by *Arlt* is similarly made, but the diameter is oval instead of round. Both were made of German silver, and of thick metal. The specula suggested by Wilde in 1844, and until lately always used by myself, are very good. They are conical silver tubes, with an outer opening of 15 mm. in diameter. The form described by Toynbee in 1850, consists of an oval cylinder, with an outer funnel shaped opening. The one here given (see fig. 5), borrows the round opening from Wilde's instrument, and the funnel shape from Toynbee's.

Politzer suggested that the specula be made of hard rubber; being black, these absorb a great deal of light. On this account, those having little experience in examining the ear, have more difficulty in seeing with them in cloudy weather, than with those which, like mine, are made of silver. On the other hand, when there is a good light, the color of the membrana tympani, which appears surrounded by a black ring, is twice as distinct. The india rubber specula are also much cheaper than those which are made of silver.

The above described method of illumination with the concave mirror I claim as my own, not having heard anything of it from another; and I showed it in December, 1855, at the Union of German physicians, in Paris. It was only till some time later, that I learned that a similar method had been proposed before, by a physician from Westphalia, Dr. Hoffman, of Burgsteinfuhrt, in 1841, who recommended the use of a centrally perforated mirror, with which to throw sunlight, or that of a bright day, into the ear, and thus illuminate the parts. This suggestion of Hoffman's does not seem, however, to have made any deep or lasting impression, nor to have been adopted by any of the well known aurists. It received so little attention that the books on diseases of the ear make no mention of it, with the single exception of that of Mr. *Frank* in 1845, and of *Rau* in 1856. The former, however, declares its illumination to be insufficient,

It is advisable for the beginner in aural examinations, to illuminate the ear with the mirror alone, before the introduction of the speculum. If the two sides of the canal be pressed apart by the fingers, a part of the membrana tympani will be seen to be strongly illuminated; and thus it is known in exactly what direction to look for it.

[illegible] TYMPANI.

[illegible] the walls of the canal, [illegible] condition, and the [illegible] as to the amount [illegible] of the cartilaginous [illegible] course of the upper [illegible] be placed close to [illegible] as far as possible, [illegible] the proper position [illegible] tympani.

[illegible] it is well to [illegible] that as small [illegible] is put in the shadow [illegible] how to give such a [illegible] the mirror, as [illegible] the illumina- [illegible] the surgeon to avail [illegible] as a source of [illegible] one side and the [illegible] the deeper lying por- [illegible] White or light gray clouds [illegible] as is the case [illegible] Sun-light thrown [illegible] causes at the [illegible] the membrana tym- [illegible] opposite us, [illegible] use the surface [illegible] as the source of light.

[illegible] which the [illegible] generally [illegible] so that the [illegible] the case of many persons, especially [illegible] and hold [illegible] of the examination, [illegible] The larger the [illegible] which is used, the easier it is to get a view of

the whole membrana tympani, and the more readily will it retain its place.

When the membrana tympani is seen, we look first for the yellow line, running from above downward, the handle of the malleus; and taking this as a guide, we then look at the other parts of the membrane. We then observe the color of the membrane, whether it be natural, regular, or different in different parts; whether the drum is translucent, or morbidly thick and opaque; whether the brilliancy of the surface be normal; if the cone of light, or light spot, is present and in an unchanged shape. Furthermore, we should observe whether the membrana tympani is abnormally flat, or oblique in position, or too concave. The observation of the position of the handle of the malleus, which is not unfrequently seen to be shortened in perspective, as well as the impression as to the size of the membrana tympani, will generally lead to correct conclusions as to these latter points.

According to Politzer, the mnmbrana tympani appears the larger, the less its angle of inclination; and I have long since frequently observed, that after the employment of the air bath, the drum seemed considerably larger. According to the same authority, the membrane, on account of the oblique position of its plane to our visual axis, always appears smaller and less curved inwards on examination with the mirror than it really is, and when seen in anatomical preparations.

We should compare the size of the two halves of the drum, and see whether the posterior and really larger half does not appear very small. We should also observe if there are not individual spots where there are variations in the curvature; if there is any vascular injection, especially on the handle of the malleus; in which latter case, the short process of the malleus appears at the upper pole of the membrana tympani exactly like a white pustule, surrounded by a red ring.

In withdrawing the speculum, we should examine the integument of the canal, and decide as to the amount and appearance of the cerumen present.

In the examination of the ear, another instrument is frequently necessary, in order to remove flakes of epidermis, clumps of ear wax, hairs, and other little foreign bodies to a perfect view of the parts. We may use for this purpose either a button headed probe, or an angular forceps, such as is seen in the engraving. The walls of the external are very sensitive, and we should be careful to avoid any vigorous contact by means of an instrument. We should call the attention of the patient to what we are about to do, in order that he may avoid all movement of the head while the forceps are in the ear. Of course, all such proceedings should only be taken when there is a good illumination of the parts. Any fluid secretion may be removed by a camel's hair brush, placed in the forceps (or by a dentist's cotton holder); and in the same way, a solution may be applied to any part of the ear.

FIG. 9.

LECTURE VI.

THE SECRETIONS OF THE AUDITORY CANAL, AND THEIR ANOMALIES.

Diminished secretion of cerumen; the importance traditionally ascribed to it; plugs of cerumen; their gradual accumulation and sudden manifestation; their structure and causes; vertigo and other symptoms; prognosis and treatment.

GENTLEMEN: In describing the diseases of the external auditory canal, we have to speak, first, of its secretions and their anomalies. In the same way that the fluid which lubricates the eye, is by no means a mere secretion of the lachrymal gland, but is also a product of the mucous membrane and Meibomian glands, so is it with the secretion of the auditory canal, which we call "ear wax." This substance is furnished not only by the proper ceruminous glands of the ear, which are very similar to the sudoriparous glands of the remainder of the skin in their sinuous structure, but also by all the other parts of the skin of the canal that have secreting properties. The very numerous sebaceous glands take part in the process; and little hairs, also mixed with the ear wax, with dead scales of epidermis, which have been thrown off.

Since the outer portion of the covering of the external auditory canal is a continuation of the common integument of the body, which has retained all its coarse and fine anatomical peculiarities, it can be easily understood, that the secretions of the auditory canal are commonly to be regarded as identical with those of the integument.

This connection or identity of the skin of the auditory canal, with that of the surface of the body, has been but little regarded, scarcely even noticed; consequently, too great an importance has been attached to its secretion, especially as to its quantity. Let us, therefore, turn our attention to the subject of diminished secretion of cerumen as well as to its increased collection.

As regards the diminution of the secretion of cerumen, we may remark that we are apt to find a dry auditory canal, with little cerumen, in persons whose integument is, on the whole, very harsh and dry, containing little fat. This state of things may exist without the least affection of the hearing. A Scotch physician, *Thomas Buchanan*, wrote several books, in the first part of this century, in which he called particular attention to the great significance of the cerumen. According to him, a large class of cases of impairment of hearing resulted from the diminution in its secretion; and thus the ear wax played a very important part in the human economy, entirely independent of the secretions of the general integument. These observations found scarcely any attention or acceptance in their time, although the dryness of the auditory canal is considered as a very important circumstance, both with the laity and the profession, with reference to acuteness of hearing. As remedies for this dryness, pencillings, and droppings of oils and balsams are practised. Among those applications glycerine has lately come into great repute. You will seldom see an ear patient, who has not, either through his own or a physician's recommendation, tried some such remedy. We find, also, in all the books on diseases of the ear up to the latest time, that the absence of ceruminous secretion is mentioned not as of itself a cause for impairment of hearing, but as a symptom of a deeper affection of the auditory apparatus. The abnormal dryness of the auditory canal, is considered by some of the latest

aurists to have great importance in the causation of catarrh of the cavity of the tympanum, and nervous deafness. *A priori*, we cannot deny that there is such a sympathy of the external auditory canal, and its secretions, with the more deeply situated parts of the ear, or that there is a certain physiological unity of the various parts; certainly they stand in dependence, the one upon the other. We can trace such a sympathy back to an anatomical basis, since the otic ganglion sends branches to the mucous membrane of the cavity of the tympanum, as also to the integument of the auditory canal.

But what does experience and cool, unbiased observation teach us here? These alone can furnish definite conclusions in such inquiries as the present. You must remember that very many ear patients very willingly ascribe the origin of their trouble to the accumulation of ear wax, and hence are apt to introduce ear spoons and similar instruments for its removal; and in accordance with their own or a physician's recommendation, to syringe the ear in order to accomplish the same result. In this way, an artificial dryness, a temporary absence of ear wax may be produced. You should always inform yourself by questioning the patient, of the possibility of such a cause producing the dryness of the ear. Apart from such cases, it is certainly true, that in many acute affections of the middle ear, accompanied by rapid increase in the amount of blood, and of the secretions, for example in acute catarrh of the middle ear, there is very often a serous exudation on the surface of the auditory canal, with a profuse throwing off of epidermis. In the similar, but chronic affections of the middle ear, however, no such reflex action upon the secretions of the auditory canal is observed. It is furthermore true, that in certain morbid drying and indurating processes, which we shall later on in the course of these lectures, recognize as sclerosis of the mucous membrane of

the cavity of the tympanum, we often, if not always, find a particularly dry and wide auditory canal.

This may be explained, however, by the fact, that persons having very little fat, with a very harsh dry skin, tensely stretched as it were over the bony frame, are more particularly inclined to such affections of the middle ear; and in persons with the same sort of integument who have good hearing, we generally find the same conditions in the auditory passage.

As to the deficiency of cerumen in nervous deafness, we shall subsequently see, on what a weak footing such a diagnosis rests.

Many surgeons assert that in acute diseases also, for example, in acute catarrh of the middle ear, there is also deficiency in secretion. It is difficult to see how such a conclusion can be reached; for if the secretion occurred normally, before the attack, it is hardly possible for it suddenly to disappear so that we would be able to estimate the present capability of secretion, from the abundance or spareness of the cerumen.

I hold to the belief, that the very prevalent idea, that many of the internal affections of the ear (we are of course not speaking of purulent affection) are regularly and proportionately connected with the diminution of secretion of cerumen, is chiefly traditional, and not confirmed by impartial observation. I can only consider the absence, diminution, or increase of the product, as dependent upon the secretory power of the integument of the body; but in this view, I do not include certain deeply seated acute inflammatory affections, affecting the whole ear, or those conditions of irritation which begin in the auditory canal. People who have an oily skin, in whom the sudoriferous or sweat glands, especially of the face, are easily excited to action, have, as a rule, more cerumen in the ear than those whose skins are dryer and harsher, no matter

whether they have chronic catarrh of the middle ear or not.

In most cases only the very moderate quantity of ear wax is secreted which covers the cartilaginous meatus as a thin layer. The superficial portion gradually becomes dry, and is lost, through the motion communicated to the cartilage of the canal, by the articulation of the lower jaw, and also during the night, in lying on the ear. If there is a vigorous secretion in the canal, more than an ordinary amount being produced, or than can be removed with the occasional aid of an ear spoon, or if there are circumstances which prevent the removal of the normally secreted wax, as is sometimes the case, or if there be any narrowing of the caliber of the auditory canal, the secretion will gradually collect, and in the course of time may completely close the passage.

Increased secretion of cerumen is by many authors referred to an acute inflammation of the canal. *Kramer* speaks of an inflammation of the cutis, whereby the ceruminous glands, lying under, are made to sympathize, as manifested by an increased secretion of ear wax. *Rau* declares the increased secretion to be the result of an erythematous inflammation of the auditory canal. That hyperemia of the canal, inflammation or congestive irritation of the integument, increase its secretion, is evident from the nature of things. Such acute irritations, however, must not necessarily be ascribed to the collection of cerumen; and I am of the opinion that the greater number of cases of closure of the canal by inspissated cerumen, must not be regarded as consequences of any kind of acute and specific disturbances of the nutritive process; but only as a result of a state of increased secretion or diminished removal existing for years, or even tens of years, until finally so much cerumen has collected, that the auditory canal becomes

filled. All the symptoms which such patients commonly speak of—a great buzzing and itching in the ear, or a feeling as if the ear were stopped up—are to be regarded as mechanical effects of the increased ear wax, and not as proofs of the described morbid process spoken of by the above named authors. This is a much simpler, and more natural view, and corresponds exactly to the results of careful and unprejudiced observation.

You have already satisfied yourselves in our examinations of the ear, which we have lately begun, how different is the amount of cerumen secreted by different persons. I called your attention to the fact, that the auditory canal of many of our fellow students has only a very little cerumen, while in others we found such a mass, on the side of the canal, that it even prevented a full view of the membrana tympani. In these latter cases we can reckon on a gradual stopping up of the canal, if the collection of a secretion be not prevented; but all these persons were shown to have healthy ears; they heard perfectly well, and were not aware of any increase in the secretion. Interruption of the function of hearing will not show itself till the stoppage of the canal be complete, and the mass is pressed in upon the drum.

The structure of many of the plugs of cerumen is also evidence that their formation occurs slowly. They are often exceedingly hard, and in old people they are generally interspersed with hairs throughout their entire thickness, and as it were tufted with them. The various secretions of the auditory canal take part very differently in different cases, in the structure of these formations. They sometimes chiefly consist of epidermis, arranged in lamellæ, filling up the entire meatus, and which, in consequence of the slight admixture of true cerumen, is only of a pale yellow or brownish color. Again, they are amorphous, of a dark brown color, composed principally of

sebaceous material and discolored exudation from the sweat glands, having some admixture of epidermis here and there in the more recent and lighter colored peripheral layers. The surface of olden plugs is sometimes as brilliant as mother of pearl, from the cholestearie existing between the layers of the epidermis. In children, where the throwing off of epidermis occurs more rapidly, such collections of cerumen have more of a bright yellow color, and honey like consistency. Bits of cotton, grains of corn, raisins, etc., at times form the nucleus of these collections, which sometimes have added to them substances collected from the atmosphere, such as coal dust, for example.

Habitual increase of the secretion of the auditory canal, which may readily lead to its obstruction, occurs in chronic eczema. It also occurs in persons in whom the integument of the head produces much sebaceous material, or who perspire very much from the head.

Among gardeners and carpenters, peasants, and rail road employés, and in general among those who are very much exposed to the sun in their arduous labors, I have found one and the same person the subject of inspissated cerumen repeatedly during the year. The secretion is temporarily increased by an often repeated congestion of the integument of the auditory canal, as well as after the repeated occurrence of furuncles. This latter form is a sort of congestive seborrhœa.

(One of the causes of the occurrence of inspissated cerumen may be said to be the habit which many persons have of pouring water into the auditory canal, for the purpose of cleaning it. This practice has a tendency to pack the cerumen into the meatus as it were, instead of removing it. I have observed several cases which seemed to me to be due to this habit. The only cleansing that the ears need, unless there be pus or the like, collecting on the walls of the meatus, is that which may be accomplished

by a bit of fine cloth, wrapped about the little finger; the natural and best instrument for manipulations in the auditory passage. St. J. R.)

In other cases obstructing collections occur in the auditory canal, without there being any excess in the amount secreted. Thus we find these plugs of hardened cerumen very frequently in old persons. This may be due to the fact that the older a person is, the more readily such a slowly increasing collection can reach an amount sufficient to close the caliber of the canal; and also because a collapse or falling inwards of the walls of the meatus, near its outer termination very often occurs in old persons, which, together with the growth of the thick, bristle like hairs, may prevent the natural evacuation of the secretion. Perhaps in old age, the cerumen is also more tenacious, and adheres more firmly to the walls.

Small quantities of cerumen may also, in some instances, excite annoying symptoms. These may occur if one of these little pieces form a wall across the caliber of the canal, even if it be a thin one, or if through any accident whatever, for example, if an attempt at its removal has not been continued long enough, and a bit of wax falls directly upon the membrana tympani, and thus causes pressure and irritation. But collections of cerumen do not generally cause any trouble until they have completely closed the auditory canal. Before this closure occurs, they are usually unnoticed. Thus we very frequently see patients coming to us, on account of one ear alone, when the other contains hardly less wax, so that only a little fissure remains unfilled. If now, through any external cause, the entrance of fluid during perspiration or bathing, the introduction of a pen-holder, hair pin, or the like, the plug becomes increased in volume, or assumes a position where it completely closes the canal, the patient suddenly experiences a condition of his ears, of which he

before had no suspicion, and which he explains as he believes with perfect honesty, to be due solely to his interference. The medical profession also erred in the same way, and, founding their opinion upon the statement of the patients, considered that inspissated cerumen proceeded from acute inflammatory processes, resulting in a sudden excessive amount of secretion.

Symptoms.—Plugs of cerumen large enough to close the canal not unfrequently announce themselves in a very disturbing manner. The impairment of hearing is often so great, that it amounts almost to complete inability to hear ordinary conversation; besides, such a foreign body as it is, increasing in size, constantly exerts pressure open, and sets up irritation in the walls of the canal and the outer surface of the membrana tympani. There is, also, an annoying itching sensation produced, or an unpleasant feeling of fullness and heaviness in the head, with extremely severe *tinnitus aurium.* Not unfrequently constant pain in the depth of the ear is felt, and even serious attacks of vertigo are experienced.

(I once saw a young lady who suffered severely from inspissated cerumen, until it was ejected from the ear with an audible report, compared by herself to that of a pistol, when some relief was experienced. She came under my care for acute inflammation and perforation of the drum of the ear in question, caused by the pressure and irritation of this plug. I found in the other a large mass of impacted wax, probably similar to the one removed *sua sponte* from the inflamed ear, but which did not yet cause any unpleasant symptoms, and which I removed with the syringe. She recovered perfectly. St. J. R.)

It is a very striking fact, and perhaps a new one to you, that these plugs of cerumen may produce attacks of vertigo. This symptom is quite frequently observed, and

must be considered as a consequence of the pressure which the mass exerts upon the membrana tympani, whereby the whole chain of the *ossicula auditus* is pressed strongly inwards, and hence upon the fluid of the labyrinth.—*Toynbee.*

There are people who only need to place the finger into the auditory canal, in order to press the whole column of air contained in it, against the drum of the ear, and thus excite dizziness, which may even go so far as to produce vomiting. Such attacks of vertigo we shall meet with in other varieties of affections of the ear, although they then, at least in part, depend on other causes. Nearly all of the profession have lost sight of the fact, that vertigo may be a consequence of disease of the ear. Many patients with impaired hearing having this symptom, have been considered as suffering from nervous disease or cerebral affection, and have been subjected to the most different and severe constitution treatment, from a course of baths at some watering place, to one of setons and moxas, while at the same time an examination of the ear would have been sufficient to reveal the true cause, when the case, in most instances, would have been treated with success.

The following is an interesting case, which shows the relative importance of the history of a patient, and of an objective examination in the diagnosis: An old man came out of a drinking saloon, where he had taken an active part in the convivial proceedings, and on the way home struck against a wagon pole, awkwardly placed in the path. He was knocked down by it, striking his head upon the pavement. He thought that he lay there senseless about fifteen minutes. How far the fall, or the several glasses of wine were to blame for this, he could not say; he admitted, however, to having been a little intoxicated. However, he got up and went home without difficulty. After a comfortable night, he found in the morning that he was almost perfectly deaf. The physician who was called in

shook his head, and immediately ascribed the deafness to the fall, and to striking the head on the pavement. He made a very serious matter of it to the family; it was at least a concussion, or perhaps apoplexy of the cerebrum. The patient, who in other respects was well, was placed on light diet, cupped, and purged, and after a few days a seton was added to the remedies. The deafness remained the same, but the patient's bodily and mental system deteriorated with the treatment. A month had elapsed when I was called in. After I had heard the history, I examined the ears, and found both canals perfectly stopped with cerumen. I caused this to be softened, and then to be removed by injecting warm water. In a few moments the patient heard perfectly well, and was cured, not only from his deafness, but also from "a profound cloudiness of his intellect," which had occurred since the "concussion of the brain." In this case, the fall had displaced the already collected, but not yet observed, mass of cerumen, so that the canal was at once hermetically closed; hence the sudden deafness.

Remember this case, gentlemen, when patients come to you, who exhibit any kind of symptoms which may also possibly be referred to the ear, and imagine yourself in the position of this intellect-clouded, medicine-tormented, seton-bothered, and easily cured patient, and think of the situation of his otherwise skillful physician, when the nature of the cerebral disease was made clear to both. Still further, let us suppose that a few days after the application of the seton, the mass of wax, through any accident, had removed its position, or that the physician had thought of applying electricity, and accordingly had placed warm water in the ear, or that olive oil or any of the nostrums for curing deafness had been dropped into the ear, and some of the cerumen removed, what a new proof would have been furnished of the effect of the remedies in cerebral deafness even.

(At a time when I was one of the surgeons of the Eye and Ear Infirmary of this city, a man presented himself on account of a noise in the head, vertigo, etc. He referred the beginning of his affection to an exposure to the rays of the sun about three months before; although, on close questioning, it was found that he had no symptom of sun-stroke at that time, although he had suddenly suffered from dizziness and the noise in the head on a very hot day. He stated that he had been treated in a hospital for two months, for affection of the head, without benefit. The removal of a plug of inspissated cerumen effected a cure of all the head symptoms. St. J. R.)

Many patients, affected with impaction of cerumen, inform us that their condition varies in accordance with certain influences, and that these variations occur with a perceptible crackling sound, or the like. Many say that they become deaf as soon as they lie down, and thus press upon the ear; and that the deafness disappears as quickly as they rise and shake the head, or pull the ear. Others become deaf every morning as soon as they wash the meatus, or clean it with a handkerchief. These are all circumstances which go to prove to us, how the masses of cerumen are affected by change of position; and that the hearing power is first markedly disturbed, when it completely closes the auditory canal.

These plugs of inspissated cerumen are by no means of an entirely harmless nature, but exactly like tumors, which are constantly enlarging, they may become injurious to the parts adjacent by their size and consequent pressure. *Toynbee* shows in several instances how harmful may be the effects, which such collections excite on the surrounding parts. He observed in connection with a dilatation of the auditory canal in consequence of pressure, deficiencies in the anterior, upper and posterior wall of the passage, besides thickening of the membrana tympani, inflammation

and perforation. I myself made a post mortem examination of a case,[1] where a plug of cerumen, wholly filling the canal, and evidently one that had existed for a long time, had produced a dilatation of the whole caliber of the osseous part of the canal, with atrophy of the periosteum, and a perforation of the membrana tympani; so that a portion of the impacted cerumen penetrated the cavity of the tympanum. Since this, several such cases have been reported by other members of the profession.

As evidence that long existing masses of cerumen, that are constantly increasing in size, may cause the partial destruction of the bony meatus, I may mention a case of which I happened to make a post mortem examination. On one side I found a very large plug of cerumen, with a symmetrical dilatation of the bony canal, and a large round aperture in the anterior wall, while the other canal was free from any collection, was of normal caliber, and in other respects in a natural condition. After the removal of a collection of this sort, we not unfrequently find the epidermis of the membrana tympani thickened, in a state of callous degeneration as it were. The membrana tympani often seems to be markedly pushed inward, as if it had been for some time pressed into the cavity of the tympanum, and it then, of course, diminishes the space of this part. We should also mention, that collections of dried pus, which are not unfrequently dark colored from admixture of blood, may sometimes be mistaken for impacted cerumen. Fungous growths in the auditory canal, to which *Wreden* has lately called our attention, may also have been mistaken for collections of ear wax.

We should be guarded in our prognosis, not immediately giving a favorable one, when we meet with such a collection, since the complications and the consequences may be very different and numerous. The use of the

[1] Virchow's Archiv., B. XVII, Sect. 11, S. 10.

tuning fork furnishes assistance in the diagnosis. (I shall speak of the value of this instrument in the examination of the ear, in a subsequent lecture.) When the tone of a tuning fork, placed with its handle on the median line of the vertex of the head, is heard better in the normal ear than in the one which is stopped up, we may be certain that some complication exists, and that the patient will not improve much in hearing after the removal of the wax.[1]

Treatment.—From the foregoing it is evident that the surgeon, in the removal of these masses, must work slowly and with care, for he cannot know in what condition the deeper parts may be. You will never, then, begin with the use of forceps, ear spoons, etc., by which the plug is easily pushed inwards, and great pain and other evil results are caused to the patient. The only proper method to be adopted is the use of injections of warm water, with which, however, we must use no violence. If the mass proves to be very hard, or the patient troublesome, we can fill the ear with warm water, and allow it to remain some time upon the plug, thus softening it, repeating the operation as often as may be necessary; and thus it may be easily loosened and swept out by the subsequent injections. Do not neglect to say to your patient, to whom you advise such a course of treatment, that the deafness will increase, lest on following your advice he becomes worse and fail to return. Oil and glycerine do not appear to loosen the masses so well as simple warm water, to which we may add an alkali, or soap. In syringing, we direct the stream as much as possible upon one or the other border of the collection, in order to more quickly loosen it from the wall

[1] Toynbee, Diseases of the Ear, London, 1860, p. 48. Of 160 ears, where he had removed such masses, Toynbee reports only sixty where the hearing power was completely restored; in forty-three, considerably improved; in the remaining sixty-two, there was no, or a very little improvement. The result of my observations has been similar.

of the canal, or from any hairs which may retain it, when the water will pass behind the plug and sweep it out as a whole, and we are able to remove it as it approaches the meatus, with a forceps. Sometimes we thus obtain a correct cast of the canal, on which we can see the figure of the outer surface of the membrana tympani.

We should not continue the syringing for too long a time at once, if the plug of cerumen be very difficult to remove. We should not be annoyed if we are sometimes obliged to give several sittings for the removal of a particularly obstinate plug, in the intervals of which the patient may use drops upon the cerumen, that may have the effect of softening it. After the cerumen is removed, the ear may be protected from the wind or cold for the next day by a bit of cotton, placed in the meatus. Cases have been observed, where a neglect of this precaution has been followed by severe inflammation of the ear.[1] Those who have the normal hearing power restored, should avoid very loud sounds; for after this great change in the condition of the ear, even the sound of a powerful voice is unpleasantly loud. Immediately after the syringing, the membrana tympani and integument of the canal generally appear more or less injected. This redness, as a rule, disappears in a few hours. If the membrana tympani be pushed inward, in consequence of the pressure so long exerted upon it, a subsequent treatment with the catheter will be of advantage. (I have found quite a large proportion of cases where the use of the catheter, or of Politzer's method of inflating the middle ear, was indispensable in order to relieve the membrana tympani from the effect of the long continued pressure of a plug of wax upon it. It is generally sufficient to thoroughly inflate the middle ear, once or twice, soon after the wax is removed. If any prolonged

[1] Schwartze, Prakt. Beitrage zur Ohrenheilkunde, S. 3.

treatment is required, the bulging in of the drum can hardly be caused by the pressure of cerumen. I have seen perfect relief follow the removal of hardened cerumen, in cases where it has remained in the canal for years. In one case, recorded in my private note book, a patient had suffered from partial deafness in both ears, and tinnitus aurium for five years; which symptoms were all removed by syringing. In another, still more remarkable case, a patient who came to my clinic at the University Medical College, asserted that she had been affected for twenty years, and that the removal of the wax afforded perfect relief. St. J. R.)

If there is any disposition to seborrhœa of the auditory passage, the part should be pencilled with an astringent, after having been previously syringed with luke warm water.

LECTURE VII.

SYRINGING THE EAR; FURUNCLES IN THE AUDITORY CANAL.

GENTLEMEN: A professor in an eminent medical faculty, to whom I announced my purpose to occupy myself especially with the investigation and treatment of diseases of the ear, responded (of course, this was years ago) with a smile: "There is nothing more to do for ear cases than to syringe the ears, and put on a blister." Many learned and unlearned practitioners ascribe a similar high and universal value to syringing the ear. Perhaps, then, I may be excused if I devote a few words to this simple procedure.

Simple as it is, we shall be able to satisfy ourselves that very often physicians themselves cannot properly syringe the ear, and that there are medical institutions where there is not even a proper apparatus for the purpose. Yet the matter is by no means an immaterial one. It is not only true that many patients are immediately cured by this simple process, but there is also a class of cases, for instance, those patients suffering from otorrhœa, who, above all things, require a regular removal of the secretion, if we would keep the morbid process at a stand-still, or improve it. We shall, at a subsequent time, inquire into all the circumstances which require a systematic and constant syringing of the ear; and we shall see that they are often cases which cause the most pain to the patient, and which not unfrequently lead to death. You see then, gentlemen, that much may depend on the possession of a good syringe, and its proper use.

I show you here the instrument which I use. It is of pewter or tin, has on one end a ring for withdrawing the piston, and on the other a blunt coniform nozzle of bone. The portion lying next to the ring, and which unscrews, is somewhat broader and more projecting, so as to afford a place for the two fingers to hold the syringe. The two rings at the side which many aurists employ seem to me superfluous. As we seldom need a long continued stream of water, or great power of the stream, smaller syringes are greatly to be preferred to larger. I recommend an instrument of this same form, but of half the size, to patients for their own use. I think horn and glass syringes the least practical. All sharp pointed instruments should be avoided, for the patient can easily do injury to the auditory canal with them, while the blunt point can be introduced without danger as far as it will go. If the instrument be too blunt and thick, the meatus is easily overfilled by it; and thus the fluid cannot find its way out of the ear, and thus the pressure on the membrana tympani becomes too great.

Fig. 10.

Metal ear syringe

In using the syringe, we remember the curvature of the canal, and that when we do not draw the cartilage upwards and backwards, the upper wall only will be washed, while the deeper part and drum of the ear will be scarcely touched by the water. We take hold, then, of the cartilage of the ear with the left hand while we are using the syringe, as we have seen is necessary in the introduction of the speculum.

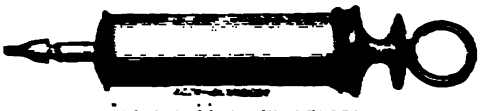
If you would be sure that the patient uses the syringe properly at home, you must give the necessary instructions. Many cases of otorrhœa are not cured, simply because the syringing is not properly performed; that is, the secretion is not removed. The syringing must be done slowly, and without force. We should especially avoid employing force in inflammations of the deeper parts; for, these having become relaxed by the suppurative process, may easily suffer injury. It is not to be doubted *a priori*, that a softened membrana tympani can be broken through by too strong a stream of water, and the *ossicula auditus* loosened from their connection with a carious cavity of the tympanum, and that the corroded walls may meet with further damage. I have also seen cases that confirmed the opinion, that, even when the membrana tympani is not relaxed, syringing, ever so carefully performed, may excite a feeling of nausea, of dizziness, or a slight fainting fit, although, according to the invariable statement of patients, there was no pain from the operation. There can be but one object in syringing the ear, and that is the removal of something from it; be it pus, inspissated cerumen, or any kind of a foreign body. When the examination has not shown that there is something to be removed, we should not attempt syringing. You may wonder that I say this to you, when it seems to be an axiom. You will be still more surprised, when, in your practice, you find that almost every aural patient, who has not come to you at first, has been ordered to syringe the ear. The patients who tell you this, will often very earnestly and truly inform you that nothing was removed.

You see, then, that many physicians employ syringing as a means of diagnosis, in order to learn if the deafness do not depend on a collection of cerumen. This latter named affection is one which plays a great part in the "probable" diagnoses of the profession.

A great deal of injury is often added to the original trouble by such careless injections, especially if they be made too briskly, or if, as is sometimes practised, very strong tea is used as an injecting fluid. I have seen inflammations of the auditory canal and of the membrana tympani arising from such causes. We should never use cold water, but only that which is luke warm, in injecting the ear; the part being intolerant of anything cold. Anything more than water is scarcely ever necessary.

(In New York, hard rubber syringes are almost invariably used for syringing the ear. I use one having a capacity of about four ounces, such as is depicted in the accompanying cut. There are practically no objections to its use in my hands, but, on the contrary, many advantages, from the powerful stream, which may be made as gentle as required by pushing the piston very slowly. Professor von Tröltsch also uses this syringe occasionally, as a foot note in the original states.

Fig. 11.



Hard rubber ear syringe.

In syringing the ears of very nervous patients, or those having very tender ears, it is well to fill the concha with

jar, to the side of which, near the bottom, a flexible tube is attached. The jar holds about half a pint. The tube is three or four feet long, with an appropriate nozzle.

FIG. 12.

Clarke's ear douche.

"In order to use the douche, it is only necessary to introduce the nozzle into the orifice of the meatus, and then raise the jar to a hight sufficient to send a current of water through the pipe into the ear. By this means a steady and continuous current is secured. It may be made gentle or forcible by elevating or lowering the jar. It cleanses the ear thoroughly and painlessly."[1]

In addition to the syringe, or when that instrument can not be used, a steel probe, roughened at the extremity, about which cotton is twisted, forms an excellent means of cleansing the ear from pus, blood, &c. St. J. R.)

Follicular Abscesses or Furuncles.—Furuncles of the auditory canal correspond exactly in their nature, to the furuncles which so commonly appear in other parts of the body. It is well known that this form of abscess is distinguished from other purulent collections, in that the furuncle has in its center a circumscribed "core," which is formed from dead connective tissue, and generally from a diseased hair follicle. The inflammation generally begins in the hair follicle; and as a consequence of the profuse formation of pus, this follicle, as also the connective tissue

[1] Observations on the Nature and Treatment of Polypus of the Ear. By E. H. Clarke, M. D. Boston, 1867.

about, is destroyed. A so called demarcated, or circumscribed inflammation develops itself about this "core," and thus furnishes still more purulent matter from the adjacent subcutaneous connective tissue. Since, however, the central mass of connective tissue becomes fully separated, the furuncle presents a great similarity to an abscess. These circumscribed abscesses may be described as swellings of varied size, flattish round in shape, of firm consistence, with broad bases, and without a well defined border. They proceed from the integument of the auditory canal, and are covered by it. Their color is often scarcely changed from that of the skin, it is seldom more than a pale red. They are always very tender to the touch. The surrounding parts are more or less swollen, so that a complete closure of the auditory canal, and with it hardness of hearing, or deafness, may occur. Sometimes the margin of the swelling is so illy defined, or the *meatus auditorius externus* is so extremely fissure-like, that it is with great difficulty, that we can find and designate the exact position of the abscess. Several furuncles not unfrequently appear near each other, whereby the symptoms are considerably increased in severity.

Symptoms.—The subjective symptoms from such follicular abscesses are as various as those occurring in other parts of the body, according to the position and extent of the inflammation. Sometimes the patient experiences little more than a troublesome sensation of fullness and of pressure in the ear, which feels very warm and as if stopped up. Again, severe pain occurs, extending from the ear to all the surrounding parts, in chewing, speaking, and in other movements of the under jaw; and this pain always increases at night. The patient complains of a feeling of extreme tension in the ear, of a continuous sensation of pounding and hammering in the head; and he cannot lie

on the affected side, because at each contact with the ear and its surrounding parts unbearable pain is occasioned. In such cases, the unrest and excitement easily change to a state of fever; and I have been before now called to patients, whose countenance and statement would have induced me to fear that they were suffering from inflammation of the middle ear, instead of simple furuncle of the auditory canal.

The symptoms are often very different, even when the inflammatory symptoms are equally distributed over the auditory canal. This is chiefly owing to the peculiar formation of the lateral section of the meatus, which, as you remember, possesses in part cartilaginous walls, and in part consists only of membranous tissue, and has an osseous margin, while it is also contiguous to soft parts. Furthermore, on the upper wall a gusset-shaped piece of integument extends to the osseous wall of the canal, and this has just as dense connective tissue as any other part, as well as glands and hairs. If, now, furuncles should occur in such a position, where the inflamed, swollen, connective tissue cannot extend itself, and quickly reaches a firm, unyielding basis, viz., the bone, the symptoms depending on tension of the connective tissue will be much severer, while if we reverse the case, such follicular abscesses will be little noticed if situated at the entrance of the auditory canal, or in similar favorable localities.

Furuncles of the auditory canal appear at every time of life, and in the most different kinds of constitution. They often occur as complications of otorrhœa, when the ear is very frequently syringed, and also when the affection is left entirely to itself. Ear drops of a solution of alum appears to produce them, as well as all ear drops which have remained too long in the canal. (I am not able to confirm the view of the author, that solutions of alum have any particular tendency to produce furuncles; but I have found

them occurring after the use of other astringents, quite as frequently as after the use of alum. St. J. R.)

A young medical man whom I treated for an obstinate case of chronic inflammation of the membrana tympani, with purulent discharge, and whom I advised the use of the above named astringent, and in order to produce a full effect to leave it in the ear during the whole night, closing the ear and sleeping on the other side, had regularly, as often as he tried the remedy, a small abscess in the auditory canal, while he could use the same astringent for months, if he left it in but a short time. Chronic squamous eczema of the auditory canal is a not unfrequent cause of furuncles in the meatus. The eczema, on account of the constant itching connected with it, causes the patient to irritate the integument with a hard or pointed substance, and thus it is brought into a state of irritation.

Course.—Resolution sometimes occurs without any discharge of pus. Generally, however, a thin yellow point gradually forms, and an opening follows in three to six days from the beginning of the attack. Then the scene ends, and at one stroke all the disturbing symptoms disappear, if a new furuncle does not immediately arise. The contents are generally a few drops of thick pus, and a fatty or flocculent mass, which we can commonly obtain only by pressure on the walls of the abscess. It is important that this "core," or nucleus, which consists of dead tissue, should be removed, because it may easily produce renewed irritation and inflammation, and because without this removal the pus cannot be thoroughly evacuated. The discharge of pus soon ceases. Just before the opening occurs, we find the surface of the tumor covered with a smeary fluid.

Prognosis.—The prognosis may be considered as a thoroughly good one, excepting therefrom the fact, that

many such abscesses quite often follow each other in a more or less rapid succession. It is well, then, to say this to the patient if only one has occurred. This frequent return of such abscesses, causing them to continue even through a long period of time, may become in the highest degree annoying, and a real source of trouble, although in themselves they are unimportant, and without unpleasant consequence. I once treated a man, who for twelve years long, with intervals of two weeks, and at the highest two months, suffered from such furuncles, now in one, now in the other ear; and with which there was always general febrile disturbance, so that at each attack he was obliged to lie some days in bed. He was thus, on account of this affection hindered in his business, which was that of a cattle dealer. Nearly all persons who suffer from frequently recurring, year long continuing furuncles in the auditory canal, are in other respects entirely well; some of them even of strong constitution, in the prime of life. Thus far, I have seen more females than males thus affected. (I have generally observed that furuncles occur in subjects in whom the nutrition is somewhat impaired. The administration of iron or some other tonic, regulation of the diet, exercise in fresh air, etc., is of course required in such cases. There are exceptions to the rule, however. St. J. R.)

Treatment.—Wilde speaks highly of the use of nitrate of silver as an abortive remedy. When the inflammation has just begun, he thinks that he has by this means often cut the short the process, and prevented the formation of pus. I have seen the development of furuncles arrested by pencilling them with a strong solution of sulphate of zinc, ʒss to ʒi to the ounce of water. Such a method of treatment is always worth the trial, although we should not forget that resolution without suppuration may occur

without any treatment. Warm, fluid applications are of service in these cases, because they decrease the tension, and hasten resolution. We may fill the ear with warm water when it is possible to do so, and place small cataplasms upon the ear, or let the steam from a vessel of warm water stream against the affected part. (This last named will be found, I think, the most efficient and soothing remedy. Let some aromatic infusion be made, as for instance of catnip (cataria). The steam of this will be very grateful. One of the many nebulizers may also be used for the purpose of applying a stream of steam to the ear. St. J. R.) A popular remedy, which sometimes does well, is the application of raisins cooked in milk. Others recommend bits of salt pork, which should be first freshened in water. If any constitutional disturbance exists, give a saline cathartic. I have not generally found leeches necessary. If used, they should be applied on the meatus, just in front of the tragus.

I incise the furuncle as quickly as possible, not waiting by any means for the formation of pus. The quicker we use the knife the better. If a complete abscess has formed, the pus is discharged, and all the pain ceases therewith. If, however, it has not gone so far, the process is generally cut short, or at least further severe pain is spared the patient. The incision should be deep and free. The skin of the cartilaginous part of the auditory canal is very dense, and somewhat thick; therefore the knife must be used with some force. A slender, sharp pointed scalpel, with a long handle, which has on the other extremity a Daviel's spoon, such as is used in extraction of cataract, with which to complete the emptying of the abscess, has proved very serviceable to me in this and similar incisions.

The little spoon can be used instead of a probe in finding the situation of the abscess, which cannot always, as has been already shown, be discerned with the eye. If we have found the most painful spot, this is the one to be cut, and

the instrument should be immediately reversed, and the incision made without giving the patient the pain of awaiting it. The cutting does not cause half so much pain as the knowledge that the next thing is to be the cutting. Great relief is experienced immediately after a rightly located incision, even when no pus is evacuated, through the relaxation of the parts, and also from the blood-letting, which is sometimes not inconsiderable. We immediately inject warm water into the ear after opening the abscess, in order to expedite the removal of blood and pus, and advise the patient to continue the applications of warm water, in order that the swelling may entirely disappear. You will, of course, understand that you are not to make an incision, which is always a painful thing, if the patient is scarcely troubled on account of the furuncle, and if you see from its situation that it will cause little inconvenience.

FIG. 13.

Scalpel, and Daviel's spoon.

Always advise patients who have suffered from furuncle to visit you a week later, or to carefully syringe the ear at about that lapse of time; because, after a furuncle, and still more, after a series of them, increased secretion of epidermis and cerumen occurs, which may cause a closure of the auditory canal. It is also possible that this discharge may induce the formation of subsequent abscesses, perhaps through irritation of the hair cysts or stoppage of the exit of the ceruminous glands. It is entirely wrong, however, to do as many patients are advised; that is, syringe the ear without cause, after furuncles have been present. (Too much stress cannot be laid upon the necessity for early incisions in these cases. The patients will thank you for them, and condemn those who attempt to wait for a natural opening, as so many physicians are inclined to do. St. J. R.) In the case of some patients, the use of an ointment of white precipitate, with occasional syringing of the ear, seems to prevent these attacks of furuncles. We should always, in the interval of their occurrence,

observe if the integument be in a perfectly normal condition, and if there be a squamous or impetiginous eczema present. By its treatment, relapses of the follicular inflammation may be prevented.

I have tried the mineral springs, and other constitutional remedies to prevent the return of furuncles, but as yet I have found them of no effect. I would most recommend the internal use of Fowler's solution.

Verneuil[1] has very lately called attention to the occurrence of abscesses of the sudoriparous glands (abcès sudoripares), which are usually confounded with furuncles. These abscesses occur most frequently in the axilla, on the arms, and about the nipple; but also occur in the auditory canal, when they proceed from the ceruminous glands. Since these latter, like the other sudoriparous glands, lie in the deepest layers of the skin, the inflammation always proceeds from within outward. These peculiar abscesses are said to be easily distinguished from furuncles by their extremely well defined boundary and cylindrical form. In the auditory canal, where they usually occur after some irritation, pruritus for example, they are said to be distinguished by the fact, that only a small spot is very sensitive to pressure.

[1] Archives génér de Médecine, 1864, II.

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LECTURE VIII.

DIFFUSE INFLAMMATION OF THE AUDITORY CANAL, OR OTITIS EXTERNA.

Periostitis of the auditory canal, as a rule, not an independent process; different causes for otitis externa; acute form, with its subjective and objective symptoms; differential diagnosis; the chronic form.

GENTLEMEN: Since in our last lecture we considered the circumscribed inflammation of the auditory canal, follicular abscesses, or furuncle, we come naturally, to-day, to speak of the diffuse inflammation of the same part, or of otitis externa. This is a form of inflammation which occurs in the superficial layers of the integument of the auditory canal, and which generally involves the entire surface of the canal, together with the outer surface of the membrana tympani.

I think that we shall obtain a better practical and objective estimation of the disease as presented by the cases, as well as a stricter anatomical basis by grouping together the various forms of diffuse inflammation of the auditory canal, under the common name of *otitis externa*. In order to a better understanding of the nomenclature here adopted, allow me to say, that by otitis *interna*, I understand the purulent catarrh of the middle ear, or of the cavity of the tympanum. The simple mucous catarrh, I call simply aural catarrh. By otitis, I understand all forms of inflammation, which cannot be considered as pertaining to one particular part of the ear. (The author's

nomenclature of the inflammations of the ear, as here given, and as will be subsequently developed, is as follows, in the order met with in this book:

1. Furuncles in the auditory canal, or circumscribed inflammation.
2. Otitis externa, or diffuse inflammation.
3. Myringitis, or inflammation of membrana tympani.
4. Aural catarrh, or mucous catarrh of the middle ear.
5. Otitis interna, or purulent catarrh of the middle ear.
6. Otitis, or general inflammation of the various parts of the ear.
7. Nervous deafness. St. J. R.)

Some authors, among whom are *W. Kramer* and *Rau*, divide the inflammations of the auditory canal into those of the cutis and the periosteum. Definite observations on a primary, isolated inflammation of the periosteum of the auditory canal, have not yet been presented, so far as I know. The cases which are reported under this name, are long standing affections, in which nothing at all can be shown to indicate that the affection of the periosteum was the primary one. On the contrary, we may often observe inflammations of the integument of the auditory canal, which afterwards produce affections of the bone lying beneath. It seems to me much more probable, according to my experience, that the periostisis is always a consequence or result of a severe and neglected inflammation of the cutis. Not only do clinical observations lead to such a view, but the anatomical facts also indicate it. Cutis and periosteum are generally so intimately connected with each other in the bony portion of the canal, that the latter can scarcely be isolated, and is certainly more easily separated from the bone than from the cutis. In consequence of the close connection of these two parts, every intense inflammation of the cutis of the osseous portion also has

its effect upon the bone beneath, and may even produce inflammation, and subsequent caries.

Many writers, among whom are *Toynbee* and *Politzer*, speak of a catarrhal inflammation of the auditory canal. The integument is certainly always thinner and more delicate, the nearer it is to the membrana tympani; but this does not make it a mucous membrane. The name *catarrh*, according to common nomenclature, pertains only to affections of the mucous membrane; hence its use for inflammations of the external auditory canal is not proper, and the name aural catarrh should only be used for the middle ear, which is actually covered with a mucous membrane. *Itard* speaks of a "catarrhal otitis externa," and of a "purulent otitis externa;" a classification equally improper with the one of which we have just spoken. The only distinctions we are able to make are between an acute and chronic diffuse inflammation of the external auditory canal.

Symptoms.—Otitis externa is a disease, which has no distinct type, but is an extremely polymorphous affection. Sometimes it occurs entirely unnoticed, and runs its course without any marked effect, either locally or constitutionally, and disappears without treatment. Just as often it appears suddenly, and with very disturbing and disquieting symptoms, which are not only felt in the ear, but which place the whole system in a febrile condition, often continuing a long time, then disappearing and returning, each time bringing with them a deeper affection, and making life a burden, on account of the severe pain, and even putting the patient's existence in danger. Each inflammation of the ear may reach such a point of danger. It is, therefore, wrong that any presumptive unimportance should lead us to regard such affections lightly in the outset, as is very frequently done, especially in practice among children.

We should never neglect the treatment of otitis externa, because, together with a certain degree of impairment of hearing, a purulent discharge from the ear almost always remains after it has run its course.

It is an affection which may appear in every time of life. It occurs far more commonly, however, in childhood and infancy, and by no means unfrequently in the first weeks and months of life. *Rau* calls attention to the fact, that each new cutting of the teeth in some children, is accompanied by irritation of the cutis of the external auditory canal.

Causes.—The causes of otitis externa are very different in different cases. It may occur from acute and chronic exanthemata, which extend from the integument of the face to that of the ear. Thus, measles, scarlet fever, and small pox, not only attack the ear from within, from the mucous membrane, but also from the integument. The eczematous eruptions of the face and of the auricle may be transplanted in the canal or occur independently and primarily. I have more than once observed in patients with constitutional syphilis, broad, moist condylomata appearing on the meatus auditorius; and after this had occurred a mild form of inflammation and purulent discharge from the auditory canal gradually appeared. At the post mortem of one patient, suffering from pemphigus, I found that the skin disease had extended to the auditory canal, and to the membrana tympani.

Otitis externa occurs quite as often from irritations, and injuries of various kinds acting from without. Some ladies are in the habit of dropping Cologne water in the ear for the relief of toothache, as recommended by *Malgaigne*; and by this means diffuse inflammation may be excited. I saw a case of inflammation, arising from frequent and long continued injections of the ear with warm chamomile tea, which were ordered and too faithfully carried out, for

impaired hearing arising from another cause. I have also seen otitis externa occur after actual scalding and burning the canal from very hot fluids. The affection may also occur after foreign bodies have been removed with an unnecessarily great degree of force; a matter upon which we shall speak more explicitly at a subsequent time.

Cold upon the ear, as for instance a draught of air blowing upon the head, when it is near a broken window, or the introduction of cold water, are frequent causes of otitis. Cold is not generally well borne by the ear, and we should protect it more than is generally done. We shall recur to this subject also in speaking of acute inflammation of the membrana tympani. (The traveler in Germany cannot fail to observe the great prevalence of the habit among the people of all classes, of stuffing the ear with cotton, even in the mildest weather. I believe that this is about as sensible a practice as stuffing the nostrils would be; the natural curvature of the auditory canal being protection enough from the open air. The cartilage of the ear will be frozen before the membrana tympani or canal will be inflamed by the contact of cold air, provided it does not reach it through a narrow aperture, as in the case of a broken or slightly opened window. Ladies formerly covered their ears with their hair or bonnet, and the amount of deafness was just as great among them as with the other sex. I do not believe there is a case on record, where inflammation of the ear has resulted from leaving the meatus uncovered in an open cold air. If the body becomes chilled, or the feet wet, or a narrow draught of air blow directly upon the head, inflammatory action may result. It is thus that cold becomes one of the causes of deafness. Of late, so called ear muffs are used to protect the ears. They are very useful for cases of inflamed or irritated ears, or for those that are very sensitive to the cold, and much better than cotton plugs. St. J. R.) All fluids placed in the ear should be previously

warmed, lest they excite unpleasant, if not positively injurious effects.

A new variety of otitis externa has been lately described in the *Archiv. für Ohrenheilkunde*, by *Schwartze*,[1] and also by *Wreden*. It is caused by a vegetable parasite, *asperquillus glaucus*, and is particularly obstinate. Dr. *Schwartze* says: "It appears to be very probable that this vegetable parasite is more frequently a cause of the obstinate, frequently relapsing, and chronic inflammation of the external auditory canal than is generally supposed." *Wreden* reports six cases, in great detail. *Mapper* reported a case in 1844 of these mushroom growths; and *Pacini* in 1851. The microscope must be used in order to detect the true nature of the growth. The forceps are generally necessary to remove the white lardaceous mass. Solutions of tannin and lead were most successful in restoring the normal condition of the canal. It is probable, according to *Schwartze*, that exudative inflammation occurred in the canal before the occurrence of these mushroom growths.

And at times we are not able to find a cause for the occurrence of diffuse inflammation of the auditory canal. Such cases occur very often in children, as well in those who are healthy as those who, on account of the swelling of the cervical glands, eruptions on the skin, coryza, and other forms of catarrh, are denominated scrofulous. I cannot warn you enough, gentlemen, from the too frequent use of the diagnosis scrofulous. It is, among too many, a convenient expedient to avoid a local examination, and a tedious and wearisome local treatment of the affected portion. The diagnosis "scrofulous" plays a great and fatal part in diseases of the ear; and yet the chief foundation for it, the enlarged cervical glands, are often only consequences of neglected discharges from the ear. If the otorrhœa be

[1] Archiv. für O., II, S. 5.

treated and arrested, the enlarged glands also disappear. We do not find catarrh of the cavity of the tympanum as a complication of otitis externa in any cases as often as in those where the otitis externa appears spontaneously in childhood; but in children, affections of the integument and of the mucous membrane very often occur simultaneously. The causes are very numerous; so that the friends of classification and sub-classification array a great list of them. Thus the otitis may be classified according to the degree of the affection, and its severity, as erythematous, erysipelatous, and phlegmonous; according to the ascertained constitutional affection, morbillous, scarlatinous, or variolous, as scrofulous or syphilitic, rheumatic, parasitic, etc., etc.

All these various forms do occur; and it cannot be denied that the course of the affection may be very much modified by the cause. For practical purposes, however, such sub-classifications are of no use to us, and you need not confuse yourselves with their recollection.

Symptoms.—These we see from the foregoing, differ according to the exciting causes, their variety and intensity. In the acute form of diffuse inflammation of the auditory canal, the patient usually complains in the beginning of an itching sensation, with a feeling of heat and dryness in the ear; which itching is so great in some cases that he can scarcely be prevented from using some kind of an instrument, an ear spoon, pin, or the like, to alleviate it. The relief of the itching thus obtained soon becomes painful, however; and without any such treatment of the parts, the morbid sensitiveness increases to a dull feeling of uneasiness in the ear, and gradually to a severe, penetrating and tormenting pain, extending deeply into the organ, almost always increasing by night, and leading to loss of sleep, febrile disturbance, and even to a mild form of delirium.

In severer cases this pain, felt in the deeper parts of the ear, extends to the surrounding parts, or even over the entire half of the head. It is increased by every motion of the body, and still more of the head, by sneezing or coughing, and at every vigorous movement of the lower jaw, especially in chewing or yawning. Such pain occurs the more readily, the more the anterior auricular region is swollen, or the more the cartilaginous portion takes part in the inflammation.

In milder cases the vicinity of the ear is rarely swelled to any extent, but is frequently very sensitive to pressure. Any motion of the meatus excites pain, especially drawing upon it. For this reason, the aural speculum should always be introduced slowly and with care.

The hearing of the affected side will be affected in proportion to the participation of the outer surface of the membrana tympani in the inflammation. It is always more or less involved in a case of otitis externa. If we examine the auditory canal at the beginning of the attack, we find the epidermis with the surface of the drum greatly injected and swelled. In this statement we are excluding the changes produced in individual cases by an exanthema or injury. The injection and hyperaemia show themselves more clearly on the membrana tympani, and its immediate vicinity, because, in the other parts of the canal, the congestion is concealed by the thicker layer of epidermis, whose saturation and relaxation prevent the abnormal vascularity of the subjacent cutis from being seen.

After the congestive stage has lasted two or three days, an exudation appears. In the beginning it is of a white color, watery in consistence. A little later on, it becomes a kind of mucous secretion; and at last, it is yellowish pus. Coincident with the appearance of this otorrhœa, which in the beginning is slight, but which is always increasing, the patient experiences a great improvement, and

the pain suddenly disappears. In some cases this otorrhœa is not so much a free formation of cells as a very abundant desquamation; so that in a very short time the whole auditory canal is filled with a white, moist, as it were, macerated lamella. I have observed this exudation oftener on the drum itself than on other parts. We can now, by injections or by means of delicate forceps, remove a number of white flakes of the size and form of the membrana tympani, which are certainly produced by its outer surface. Some are also of the shape of the walls of the canal. I have observed such desquamations chiefly in cases where the pain was very severe and extensive. The pain and importance of the affection are the greater, the more the membrana tympani and deeper parts are involved.

If we make an examination at a later period of the morbid process, or during the stage of exudation, the canal must be previously cleared by injections or pencillings. If the syringe be very large, and the stream very strong, it is easy to perforate the membrana tympani. On account of the great amount of swelling and infiltration, it is difficult to appreciate the condition of the different parts of the canal, especially the deeper ones; their appearance and relative position being greatly changed. The examination is also often made more difficult, on account of the amount of the secretion adhering to the wall, and on account of the saturated scales of epidermis which are in the caliber of the canal, and which can only be removed after some time has elapsed.

But apart from such hindrances to a complete view of the parts, the auditory canal appears slightly contracted on all sides. The line of demarcation between the margin of the membrana tympani and the end of the meatus does not distinctly appear. The epidermis on both parts is relaxed, saturated and swelled, and the surface is covered with a purulent deposit in certain spots; while in other

situations the integument is removed. Where the latter has occurred, an evenly red, often only slightly swollen surface is seen, on which we are not able to distinguish individual vessels, and which resembles a granulating wound, or a blennorrhœic conjunction. These spots, in which the process of throwing off epidermis has begun, are frequently covered by isolated bits of epidermis, or by a thin layer of pus, which, when removed, are replaced almost under our eye.

After the purulent discharge has once appeared, a stage which is very welcome to both physician and patient on account of the cessation of pain, it always continues for a time; but under favorable circumstances, it may gradually abate, and even entirely cease without any treatment. It more frequently becomes chronic, however, if it be not treated, and lasts for years, with varying degrees of severity, and may even continue throughout the whole life, with occasional interruptions. Quite a proportion of the cases of otorrhœa, coming under treatment, may be referred to such an inflammation of the auditory canal as their starting point.

In the beginning of a painful inflammation of the auditory canal, or when it has become impossible to examine the more deeply situated parts, it is not always easy to decide whether we have a circumscribed inflammation, proceeding from a follicle or gland, or one of the diffuse variety. The latter acts more upon the superficial integumentary layers, but very soon causes a symmetrical saturation of the epidermis, and a concentric but rarely very great contraction of the passage. In the furuncular variety of inflammation, which involves the deeper layers of the cutis, and especially the cartilaginous meatus, the swelling is somewhat more localized, and projects forward into the meatus from one point.

If the membrana tympani can be examined, its outer

surface will be found in a corresponding condition to that of the canal, if the case be one of otitis externa. If, however, there is only a circumscribed furuncular inflammation, there only occurs a saturation of its coating of epidermis; and this takes place at a later period. The impairment of hearing in the furuncular variety of inflammation, increases in proportion to the mechanical closure of the meatus. In otitis externa it depends upon the amount of thickening in the membrana tympani. In the latter form, suppuration is apt to occur rather earlier than in the former.

Besides these two varieties, certain mixed ones may occur, as, for example, extensive phlegmonous inflammations of the sub-cutaneous cellular tissue, after severe injuries. I should also mention that secondary abscesses occur also in the auditory canal in suppurative inflammation of the middle ear. These extend to the glands already described as existing in the upper and posterior wall of the osseous meatus.

I shall take occasion to speak more in detail of this form of abscesses, which are very frequently mistaken for furuncles, when we come to speak of the different kinds of otorrhœa.

Very often, however, the patients who present themselves with otitis externa do not speak of such a painful and acute origin; the affection has begun more insidiously. Such a chronic form of disease is quite as common as the cases which are developed from the above described acute variety when left to itself, or from those which are not at once properly treated. They occur most frequently in childhood.

The subjective symptoms are at first so slight that the moisture of the ear first calls attention to the affection. Painful symptoms sometimes exhibit themselves, however, even when the affection has existed for a long time with no more disturbance than a discharge from the ear, and some impairment of hearing. Sometimes the otorrhœa

occurs periodically, disappearing, for example, in summer to return in the winter. In this form we find the canal only a little swollen, its covering softened, as if macerated, bleeding very readily, and covered with a secretion, or with brown crusts that smell offensively. Great vascular injection is only to be observed in the deeper parts, and on the membrana tympani. This membrane seems flattened, its cutis is thickened; and since this is densest over the malleus, the latter can scarcely be seen. The amount of the secretion is very various, changing according to the time of year and other influences. At one time the meatus is almost dry; again, there is a profuse discharge of a thin, yellowish fluid, with an extremely bad odor, which excoriates the skin around the ear and neighboring parts, and soils the clothes of the patient.

I have never been able to measure the exact amount of the discharge in any given case; but I have seen cases where it was at least from three to four ounces daily. Such cases of profuse secretion we generally find in the case of children of the lower classes, or in those who are not always kept clean, and among whom the continuance of the filthiness is even advocated by the assertion that the disease must be cured by being driven out of the system from within, and not by "driving it in," lest dangerous internal diseases should arise. These children, who, except as to the ear, are often rare specimens of vigor and health, are treated for months and years with iodide of mercury, Plummer's pill, laxatives, cod liver oil; all sour and fat food, even fruit is forbidden them; and as if the region of the ear were not foul enough, it is made more so by means of tartar emetic ointment, and other vesicants. In short, all conceivable remedies will be used to cure the discharge from the ear, without one thought of the first surgical as well as domestic law, the law requiring cleanliness before all things.

(The preceding very just remarks of the author as to

the preeminent necessity for local cleanliness in treating these cases of purulent discharge from the auditory canal, should not be construed as countenancing any disregard by the physician, of the hygienic condition of the little patients. In our city practice among half starved and badly fed children, huddled in crowded, unventilated, and damp tenement houses, we are often obliged to expend more energy in enforcing hygienic rules, than those who practice among children living in our country districts, where wretchedness and disease do not reach such frightful extents as with us. A correction of the improper sanitary condition, does wonders in cases of asthenic inflammation of any organ. St. J. R.)

LECTURE IX.

OTITIS EXTERNA (continued).

Consequences; prognosis; treatment; vesicants, cataplasms, and instillations of various oils.

ABSTRACTION OF BLOOD IN AURAL DISEASE.

Choice of point of application of leeches; precautions in their use.

NARROWING OF THE AUDITORY CANAL.

Exostoses and hyperostoses.

GENTLEMEN: We may now consider the consequences of otitis externa, the disease whose study we entered upon at our last meeting. More or less thickening and opacity of the membrana tympani are apt to remain after such an affection. These changes will cause a certain amount of impairment of hearing. A more important consequence is the formation of polypoid growths in the course of a long existing otorrhœa, which tend to increase the secretion, and often cause blood to be mingled with it. A number of other pathological changes occur through the irritation of the pus remaining upon the meatus. This finally sets up an inflammatory condition. The most frequent result is an ulceration of the membrana tympani. The affection which was hitherto external, extends itself to the inner parts; so that from an otitis externa, a much more serious form of disease—otitis interna—is developed.

On account of the great importance of purulent discharges from the ear, in a pathological and practical point of view, we shall, at a later period in the course of these

lectures, devote special time to their consideration. At this place, however, I may call your attention to the fact, that not only suppurative processes of the middle and external ear, but also those that are located in the external ear alone, may lead to the evil consequences that you have observed on some of the patients at the medical clinic of this University. I need only call your attention to the contiguity and nutrient relation of the cutis and periosteum of the auditory canal, of which we have already spoken, and at the same time recall to your mind the exact situation of the canal with respect to other parts. (See fig. 2, p. 22.)

Of course, the proximity of the transverse sinus, the dura mater and the cerebrum, as well as the fact that partitioned cellular osseous spaces, which in part contain air, and are in part diploetic, lie next to the canal, must have an important influence upon the course of inflammatory and suppurative processes in the ear. Such affections, even without any participation of the cavity of the tympanum, without a perforation of the membrana tympani, and without any evident caries of bone, may lead to a result that puts the life of the patient in danger.

Toynbee[1] details such a case of inflammation of the external auditory canal, which, without perforation of the membrana tympani, and without any superficial ulceration of the bone, led to purulent menigitis. All the particulars are given, both of the history of the case and of the post mortem section. *Gull*[2] reports another case, where, in consequence of caries of the upper and posterior wall of the auditory canal, and where the membrana tympani was intact, though thickened, a thrombus occurred in the transverse sinus, and in the jugular vein.

In two cases in which I made post mortem sections, there were fistulous passages leading from the the posterior

[1] Diseases of the Ear, p. 63.
[2] Med. Chirurg. Transactions, XXXVIII, p. 157.

wall of the auditory canal, through the mastoid process to the sigmoid fossa, accompanied of course by other changes in the deeper parts of the canal; and in the one case, where there was an extensive thrombus in the transverse sinus, the destruction of the thrombus began where the fistula in the bone had opened.

These anatomical considerations are doubly worthy of notice in children, where the osseous layer between the auditory canal and the brain is very thin and porous, and where there are numerous openings for blood vessels, which lose themselves in the bony substance, and communicate with branches coming from the dura mater. Purulent discharges from the ear are very common in childhood, and very little attention is paid them by the laity and physicians when thus occurring, but they are left to themselves unless some especial symptoms call attention to them.

In post mortem examinations of these parts, the diploetic spaces, as well as the cerebral sinuses, are not always examined; and it may sometimes have occurred that the true cause was overlooked, which, under the form of meningitis, pleuro-pneumonia, typhoid, or pyæmic conditions, led to a fatal result. Never omit, in the diseases of children, where the signification of the symptoms is so uncertain and doubtful, to examine, both at the sick-bed and on the post mortem table, as to the possibility of the origin of the trouble in the ear.

Prognosis.—This necessarily varies in the acute variety very considerably, according to the exciting causes. An idiopathic inflammation of the auditory canal, or one produced by some not very severe injury, allows a favorable prognosis, if the disease be recognized and appropriately treated. The secondary form, occurring in the acute exanthemata, often results badly, because, in the danger of the constitutional disease, which may be great, even threatening

the life of the patient, the affection of the ear is either not carefully observed, or is entirely overlooked.

The more the membrana tympani is attacked with the inflammatory process, and is involved in it—and this is often the case in the acute exanthemata, or when there is at the same time an acute inflammation of the cavity of the tympanum—the greater difficulty we shall have in avoiding a perforation of the membrane. However, when other circumstances are favorable, the perforation is not so extremely serious, for generally it may be healed. The prognosis is much more uncertain if the disease has existed for some time, and if important changes have already occurred, in other words, if there is a chronic otitis externa.

As will be seen from these remarks, every otorrhœa is a serious matter, which is certainly dangerous to the hearing; for we cannot be certain as to how much part the adjacent structures, viz., the vessels and bones of the ear, will take in the process. The prognosis in every chronic otorrhœa must be considered uncertain and doubtful, although the form which is confined to the external ear, is generally cured, that is, the discharge gradually ceases, and the hearing returns to a certain degree.

Treatment.—The treatment of otitis externa, in the beginning of the acute form, as well as in each sub-acute stage of the chronic form, is an antiphlogistic one. The patient should remain in-doors, be placed on light diet, and take a saline cathartic. Leeches are almost always required, and those should be placed anterior to the external meatus. As a rule, from two to four will be enough; and occasionally their application will require to be repeated, if the pain and other inflammatory symptoms continue. Next to leeches, nothing so quiets the pain as often filling the ear with lukewarm water, leaving it in the ear, the patient at the same time lying on the other side,

from five to ten minutes. If suppuration has commenced—otorrhœa—we must above all things secure the removal of the secretion; and to this end, the ear should be syringed three or four times daily. This performance is generally extremely pleasant to the patient, if the temperature of the water be properly regulated, and the injection be made slowly. In the intervening time the patient should lie on the affected side as much as possible, in order that the secretion may have a free exit. In order that the patient may lie on the affected side without difficulty, I sometimes use ring-shaped pillows with great advantage. The exit of the discharge may be assisted by long strips of lint or linen placed in the ear. These last suggested appliances are good ones to be used in all cases of discharge from the ear, since they cause no irritation, and perfectly absorb the pus, and may be renewed as often as is necessary.

In order to diminish the secretion, you may use astringent lotions, weak solutions of alum, acetate of lead, sulphate of copper or zinc, with which you fill the canal after it has been cleansed. The same solutions, gradually increased in strength, should be used in the chronic form of the disease, and should be retained as long as possible in the ear. They should be always warmed, and never be cold when dropped in. A small reagent-glass may be used for warming the lotion, and prescribed with the astringents. When there is only a slight amount of discharge, we may remove it by means of a camel's hair pencil. (A delicate cotton holder, such as dentists employ, is also a very convenient means of cleansing the ear. St. J. R.)

Let us now devote a few moments to the means of treatment which are often recommended for otitis externa, but whose use I can only advise you to abstain from. First, then, there are blisters and irritating ointments, which are indiscriminately applied over the mastoid process, in almost every form of aural disease. In acute

inflammation they increase the pain and irritation; and in children and persons with a delicate skin produce an eczema in the region of the ear. In chronic cases, however, they will seldom do harm, but certainly no manner of good. We have had full opportunity to collect experience on this point, since almost every patient with chronic affection of the ear has tested these agents in some form or other. Who will deny that in a case of otorrhœa, a long continued discharge behind the ear is an annoying affair, and a chronic source of uncleanness?

Dry heat, applied by means of warm cloths, or warmed cotton, which are commonly used in stilling pain in the ear, diminish the pain somewhat; but it returns in a greater degree so soon as their use is discontinued; and thus the inflammatory condition is considerably increased. Moist applications, such as poultices, are common among aurists and other practitioners. I formerly made use of them, but have now nearly discontinued the habit, only making use of cataplasms in the case of furuncles, or of entirely superficial diffuse inflammation of the canal. Nothing stills the severest pain in the ear so quickly, and exerts such quieting influence. No remedy shortens the painful congestive stage so much as the application of poultices in the various forms of otitis; since it quickly produces exudation and discharge, and with it cessation of tension and pain. There can be no question as to the truth of this experience. But in spite of all this, I warn you against their use in all deep seated inflammatory processes in the ear, because nothing is so adapted to produce profuse and wearying discharges as the application of poultices.

Schwartze does not use poultices even in furuncles, because he has several times observed that diffuse inflammation of the auditory canal, and once even a perforation of the membrana tympani, followed their use.

When I compare the results of my present practice with

those of the period when I commonly used poultices, I perceive a very marked difference; in that now a perforation of the membrana tympani seldom occurs, and the subsequent discharges are much less obstinate. This is a fact well worthy of notice in all inflammations where the membrana tympani is affected; and I am of the opinion that the number of cases of otorrhœa, and affections of the temporal bone, would be sensibly diminished if all inflammations of the ear were not so indiscriminately treated by the application of cataplasms.

The practice of frequently filling the ear with warm water, which is a clean and interrupted cataplasm, will greatly diminish the pain, if not quite as much as the application of a poultice to the whole region of the ear; and from it, I have never seen any such excessive deliquescence and relaxation of tissues, such as very often occurs from the method generally practiced.

If we refer to the analogous condition of affections of the eye, for a proper estimation of this practically important question, we know that in blennorrhœa of the conjunctiva, warm applications produce destruction of tissue very quickly, and that we can excite an intense form of blennorrhœa by the use of cataplasms. In an old case of pannus, for instance, warm poultices produce almost the same effect as inoculation with blennorrhagic secretion.

Finally, as to the dropping in of warm oil, which is practised by some aurists. It possesses no kind of advantage over the dropping in of warm water. On the contrary, there is the positive disadvantage, that oil is a kind of foreign body, an adhesive substance, which is not fitted to come in contact with an irritated surface which has been deprived of its epidermis. Glycerine is better, not being adherent, and being soluble in water, so that it can be removed by syringing. However, simple water does the best service.

We should also use only warm water in injecting the ear. Additions of milk or vegetable decoctions (chamomile tea is especially employed in Germany), are not only superfluous, but positively harmful; because in their use organic material is always left behind, which may easily set up an irritation in the ear, or may undergo decomposition.

Local Blood-letting.—In the subsequent parts of this course of lectures we shall often have occasion to speak of abstraction of blood, and of the use of leeches in affections of the organ of hearing; and I may, therefore, to-day go a little more into detail on this point.

In certain aural inflammations, local abstraction of blood is a highly important remedy. I scarcely know any condition where the immediate effects of treatment, especially in regard to the diminution of pain, are so striking as in the use of leeches in affections of the ear. Yet they should be properly employed, and certain precautionary rules adopted, or they will do no good, but may even cause harm.

The mastoid process has been commonly chosen as the point of application of leeches in all forms of inflammatory affections of the ear. *Wilde* first called attention to the fact, that in most of the painful affections of this organ, and these are chiefly the inflammations of the external auditory canal and of the membrana tympani, a few leeches applied on the meatus, and particularly in front of it, did much more good than a much larger number applied behind the ear. We may often have an opportunity in practice to notice the comparative effect of the application of leeches at the two points in the same person.

The anatomical explanation of these facts may be found in the course and origin of the external vessel of the membrana tympani, as demonstrated by myself. We now know that the external meatus and the membrana tympani receive the most of their vascular supply in common, from

branches of the deep auricular artery, which passes off behind the articular process of the lower jaw, i. e., in front of the meatus; and that they first supply the tragus and the anterior portion of the auditory canal.

The deep auricular vein also lies in front of the meatus. This is the principal vein of the external ear. When we wish, therefore, in affections of the auditory canal and of the membrana tympani, to evacuate blood from a point nourished by the same arteries with the affected part, we should choose, not the mastoid process, but the meatus, particularly the tragus and its immediate vicinity. All this refers to affections of the external ear.

The circumstances are different, however, when we are dealing with disturbances of nutrition, which are more deeply situated, when we have an inflammation in the cavity of the tympanum, and in the adjacent bones. In such cases where, however, we have not much to hope for from blood-letting, we may apply the leeches on the mastoid process, under the ear, or near the style-mastoid foramen, or even in front of the ear, since the cavity of the tympanum and the neighboring bones draw their blood supply from various sides, partly from the tympanic artery, which passes through the Glaserian fissure, i. e., at the articulation of the jaw, and from the style-mastoid, which enters under the meatus into the Fallopian canal. The mastoid process and the adjacent bones receive their blood supply from the arteries of the dura mater and pericranium, from within and without. This process is also penetrated by a number of vessels, which unite the external veins of the membranes of the brain, and the sinuses and veins within the calvarium, in part by an indirect connection by the *venæ diploicæ temporales posteriores*, in part directly through the *venæ emissariæ mastoidæ*.

In drawing blood from the mastoid process, we may cause a quick and full stream to flow by means of *Tourte-*

loupe's artificial leech, and may take blood not only from the membranes of the brain and the bones, but also from the veins and sinuses on the interior of the skull.

I have still to add a few rules for the application of leeches on, or in front of, the meatus. You should always indicate the place of application with ink. If you do not close the auditory passage with cotton, blood will run in, which may coagulate there, and increase the malady of the patient. The leech itself may also get in. A physician once told me that he applied a leech to the ear which crept in, and caused such excessive pain that he thought it must have bitten the membrana tympani; and so it remained for an exceedingly painful hour. I think in such cases we could help the matter by dropping in a solution of salt or a small quantity of oil. It is best, however, to prevent such an accident by stopping up the auditory canal. It is also well to tell the patient the means of arresting the bleeding; for occasionally the hæmorrhage proceeds further than is wished, especially from the temporal and aural region. These means are, long continued digital compression, pressure with punk, which, if necessary, is saturated with *liq. ferri sesquichlorati*, or the like. I know a case in which a leech, placed upon the temple, was the immediate cause of death, in a child of two years of age, because those about were not able to check the hæmorrhage. The child died of debility a short time after, in consequence of the loss of blood, which was excessive for its tender age. After the bleeding has ceased, cover the bite with a piece of court plaster, or similar material. There are cases which react to every leech-bite, with erysipelatous swelling of the face and head. Whenever the wound easily becomes unclean, as for instance in otorrhœa, this is very apt to be the case. It is not long since that I saw, on a patient for whom I had ordered a leech applied, erysipelas, extending from the place of application over

the whole face, and which assumed such proportions that it was only by the most energetic means that I could restrain its progress. In this case I had every reason to suppose that the erysipelas arose from contact of a purulent discharge with the wound of the leech. "Little causes, great effects," is a sentence whose full import is yet to be comprehended in the practice of surgery. Do not consider little things too lightly, and you will very often guard against great injury.

Narrowing of the Auditory Canal.—Before we leave the external auditory canal, we have still a class of conditions to consider, which cause contractions or narrowings of the canal, of various degrees and shapes. They occur not only in the cartilaginous but also in the bony portion of the canal.

The most frequent variety is the fissure or slit-like contraction of the cartilaginous portion of the canal. The anterior and posterior wall, particularly at the entrance of the canal, lie more or less close together, so that its usually oval caliber is changed to a longish slit or fissure, or it is entirely removed. Up to this time, I have observed high degrees of this variety only in old persons. In one very marked case which I observed during the lifetime of the patient, and also in a section of the parts after death, the dense fibrous tissue which forms the upper and posterior portion of the auditory canal, was in a condition of extreme flaccidity, and sank towards the anterior wall. Of course, still other causes may produce the same result. It appears to me that such a flaccid condition of the fibrous tissue is the principal reason for the narrowing of the canal.

The view of *Larrey* (*pere*), that the loss of the molar teeth, and the thereby changed position of the under jaw, caused the cartilaginous walls to fall together, is certainly incorrect. The head of the lower jaw would rather exert a

gradual influence upon the osseous canal; but according to the examinations as yet made, such an influence has not been verified.

As frequent as the slit-shaped contraction of the auditory canal is, it is only rarely that it increases to such an extent as to exert any considerable influence upon the acuteness of hearing. But the normal evacuation of the cerumen is interfered with by this condition, and therefore accumulations readily occur, especially in old people. Persons, whose impairment of hearing depends upon this falling together of the walls of the canal, hear better as soon as the auricle is drawn back, or when the speculum has been introduced.

The so called "Abrahams"—small silver or golden tubes, with a funnel-like expansion, so often found in use among those partially deaf—are useful alone in these cases of collapse of the meatus, although they are recommended for all forms of deafness. They are very readily bought by patients, on account of their small size, and the fact that they are scarcely noticed when worn. Senile deafness, at least of a high degree, depending on this collapse of the walls of the canal, is very rare however. I have only as yet observed a very few typical cases of this sort.

A ring-like, or annular contraction of the walls of the canal on all its sides is occasionally observed as a congenital anomaly of development. I once saw a case of this kind in a boy, existing on both sides to such a degree that at first I thought it was a case of congenital closure of both auditory canals. The patient understood low-toned conversation at several feet distance, so that he was able to be educated at college. He could only hear a watch, however, which should be heard at five feet by a normal ear, when it was laid upon the auricle. He could hear it better when laid upon the adjacent bones. On closer examination, it was seen that the cartilaginous part of the canal

extended inward like a funnel. On drawing the walls apart, at the apex of this funnel, a narrow canal was found.

This canal was somewhat larger on the left side than the right, so that a probe of one-half a millimetre in thickness could be introduced, although it caused some pain. Since this dilatation caused the patient to hear much better, I advised a methodical continuation of this treatment, but I never saw the patient again.

In another case, I saw a similar although not so great a contraction, also beginning at the meatus, and on one side only. There were also two elevated brownish-colored spots just in front of the tragus; in which position, at the time of birth, there had been a small lobule, which had been removed by ligation some time before. These contractions of all the sides of the canal are more frequently the result of thickening of the integument, such as often occurs after frequent or chronic inflammations of the auditory canal. In one case, I saw such a contraction of the caliber of the canal, caused by the frequent occurrence of furuncles, which always appeared on this one ear alone. It is most frequently caused by chronic eczema, which, in consequence of the thickening of the integument, changes the auricle to a misshaped structure, and more or less lessens the size of the auditory canal. Occasionally it completely closes it. This condition may be generally relieved by the well known treatment of the eczema, with astringent fluids, or still better with ointments of zinc, or of white or red precipitate. These are pencilled upon the affected parts.

In one case in which the soft parts had become so thickened, that the almost closed canal could only be entered by a very delicate probe, I succeeded in dilating the passage to such an extent, by the daily application of compressed sponge, as to enable me to examine the deeper parts with an aural speculum, and to treat the chronic

otorrhœa interna from without. Recently I have used laminaria digitata, as a means of dilatation with great advantage.

Exostoses and Hyperostoses.—Three forms of contraction occur on the bony portion of the canal. The most frequent variety, but one that never exists to a very high degree, consists in a great projection of the anterior wall, close to the membrana tympani. It occurs at every time of life, and is by no means limited to persons without teeth. When the auditory passage is thus encroached upon we can scarcely ever, however much we pull back the auricle, or push the speculum upward, see the anterior and lowest portion of the membrana tympani, or the periphery of the triangular light spot. This hindrance to a full view of the membrana tympani is, so far as I know, the only influence which this abnormal condition of things exerts upon the ear.

Exostoses of the auditory canal are by no means of unfrequent occurrence. They are hard tumors of varying size, with a roundish surface, sometimes smooth, and in other cases irregular. The base of such tumors runs into the surrounding bone, although it is usually quite well defined. They usually have a broad base, although some of them are pedunculated. The integument covering them is usually somewhat reddened, rarely very pale; and on touching it with a probe, quite severe pain is usually caused. (I have, contrary to the experience of Professor Tröltsch, never found those growths very sensitive. St. J. R.)

They occur not only at the beginning of the osseous canal, but also close to the membrana tympani. They are almost always found on both sides, and several growths often proceed from different parts of the canal. I have several times observed such growths developed to such an extent, that the canal was almost obliterated. They occur much

more frequently in men than women; and they occur much less frequently as a result of painful inflammations than without any apparent cause.

Toynbee considers these growths an evidence of a gouty or rheumatic diathesis. I have seen them as yet, chiefly in men who were good livers; but I have never found any trace of arthritic deposits, and I have considered them as a co-incidental effect of catarrh of the cavity of the tympanum.

The growth of these tumors usually advances very slowly. The syphilitic diathesis has usually no connection with their growth. These exostoses have been very frequently found in the skulls of natives of America.[1]

Treatment.—According to my experience, very little is to be expected from attempts to enlarge the canal by means of compressed sponge or lammaria digitata, or from the use of iodine locally and internally. It is very important to tell the patient to cleanse his ear very carefully with a syringe or camel's hair brush, since even small bits of epidermis, when thrown off, may tend to closure of the canal. Pedunculated exostoses may be readily broken off, but they do not usually lessen the caliber of the canal. When closure of the canal is induced by these growths, they may be removed by cutting, perforating, sawing and filing, and an improvement to the hearing expected. We should hope more from these operative removals, if post mortem section did not show that it is only exceptionally that they are hollow; that is, that they are osseous vesicles, such as occur in the temporal bone, not only in animals but also in men.[2] The most benefit will result from the im-

1 Welcker Archiv. für Ohrenheilkunde, I, 3, S. 172.

2 Autenrieth, Reil's Archiv. für Physiologie, 1809, IX, p. 349, found such a growth to be cellular in its internal structure; and there was no connection of the air cells with those of the mastoid process.

provement of the catarrh (purulent) of the cavity of the tympanum.

Hyperostoses are attended with symptoms similar to those from exostoses. They not unfrequently occur in chronic otorrhœa, or remain after it. In this case we generally find the walls of the canal contracted on all sides throughout its entire course. There are occasionally slight irregularities in the bony enlargement, while the exostosis, with its base well defined, owes its origin to an increased amount of local nutrition. The flat, undefinable hyperostosis is the result of a more decided inflammation of the periosteum, and belongs to the class of osleophytes. As a rule, the integument of the contracted auditory passage is more or less reddened.

In cases where a secretion of pus is going on beyond the membrana tympani, such bony growths may prevent the exit of the discharge, and thus be an immediate cause of death. Dr. *Roosa*,[1] of New York, has reported an extremely interesting case of this sort, where, in consequence of the retention of pus, meningitis was developed.

(I have appended to the author's remarks on exostoses and hyperostoses the following cases; the first being the one just alluded to. The cases, except the last, which has never before been published, were first reported in the New York Medical Journal, as above quoted from.)

Case I.—Mr. C., æt. 39, was seen in April, 1864, in consultation with Dr. C. R. Agnew, under whose care he had been for some time. He had lost, before coming under observation, the hearing of his right ear, by inflammation and caries of the middle and internal ear. Previous to the above date Dr. A. had removed a sequestrum, consisting of the cochlea and semi-circular canals, from the depths of the external auditory canal of the ear, and thus terminated the inflammatory action. In early life, Mr. C. had also suffered from "inflammation" of the left ear, producing the bony growths in the external auditory canal,

[1] New York Med. Journal, March, 1866: Year Book of New Sydenham Society for 1866.

which render his case the subject of present description. He now hears with his ear a watch tick at a distance of five inches. In the auditory canal, near the meatus, are two bony enlargements, which rise from the anterior and posterior walls, and project in a conical form, so as to occupy at least three-fifths of its caliber. These tumors have all the physical appearance of exostoses, and seem to have originated in periosteal inflammation. They have been steadily treated for many weeks by the local application of the saturated tincture of iodine, and certainly not diminished in size. Pressure upon them excites pain, and induces an increase of swelling in the skin which covers them, and thus temporarily adds to the deafness. The entire absence of hearing in the fellow ear, and the failure of simple means to render the exostoses smaller, have suggested the propriety of some surgical operation for their removal.

Such a proceeding has been thus far postponed by the occurrence of an acute attack of inflammation in the part, and extending to the tympanum, with symptoms of more than usual cerebral irritation. From this disagreeable complication he has entirely recovered, under Dr. Agnew's care.

His general health being impaired he went abroad, and while in London consulted Mr. Toynbee, who used bougies, hoping to dilate the canal, but, according to Mr. C's statements, they caused much pain and accomplished nothing. Through Dr. Agnew's courtesy I again saw the patient in the spring of 1865, and found that the growths had so increased that only a small probe could be passed between them, and the hearing more impaired. The patient could still, however, hear the watch tick, but only when laid on the auricle.

(The patient, whose case is here given, died of inflammation of the membranes of the brain, induced by suppuration in the cavity of the tympanum, the pus not being able to find an outlet, on account of the presence of the exostoses. Dr. Agnew exhibited the brain and temporal bones before the New York Pathological Society. The history of the other ear of this unfortunate patient will be found in one of the subsequent lectures.)

Case II.—A gentleman, æt. 40, whom I saw but once, in June, 1864. He states that he had a "running" from his right ear for a number of years. For some two or three years past he had observed that the ear was stopped up. He was accustomed to remove the accumulating discharge by thrusting in a match armed with cotton.

There is seen a bony growth arising from the posterior wall of the meatus, and involving the whole caliber of the canal, except a space large enough to admit an ordinary sized silver probe. Through this opening a slight amount of purulent discharge constantly makes its way. There was some hyperæmia of the pharynx, and there was a small ulcer on one of the tonsils. The patient was in excellent general health, was rather a free liver, and said he had constitutional syphilis; but no good evidence of its existence now existed. The patient had never had rheumatism or gout.

Case III.—Mr. S., æt. 25, Conn., February 6, 1865 (a patient sent to me by Dr. Alfred North, of Waterbury). When the patient was three or four years of age he had scarlet fever, at which time his ears began to discharge; and they have continued to do so at intervals ever since, with attacks of pain in the ears, which sometimes lasted for weeks, and prevented him from any occupation for the time. Eight years ago his ears were examined and polypi discovered; one of which was removed by caustics. The attacks of pain have continued to occur, the discharge continues, and his hearing is become more and more impaired. He is just now suffering from acute pain referred to the left ear. He hears the watch about one inch from each ear.

In the right meatus there is seen a bony growth, reaching nearly out of the orifice of the external meatus, and arising from the posterior wall. The space between the growth and the anterior and upper wall is about large enough to admit of the introduction of a camel's hair brush. In the left meatus there is seen a gelatinous granulation, also reaching nearly out to the orifice of the meatus.

On blowing air into the cavity of the tympanum, by means of the Eustachian catheter, air and fluid are heard making their exit into the external meatus; but the blocking up of this passage prevents their emergence. On the right sight pus may be seen in the orifice between the bony growth and the wall of the meatus.

The confinement of the fluid in the middle ear accounts for the pain in the left side, and the indication of treatment was to secure its free exit. This was done by removing the gelatinous growth by torsion, the patient being etherized, and rendering the Eustachian tubes permeable by the use of the well known means,—the catheter and Politzer's method. The granulation was found to have its origin from a general bony expansion of the meatus. This growth had no

one point of attachment, but involved all the sides of the meatus, somewhat more expanded externally, giving the bony canal rather a funnel-shaped appearance. The bone was roughened. The pain in the ear disappeared as soon as these means for securing an outlet to the pus, constantly secreted from the cavity of the tympanum, and passing through the perforated membrana tympani, had been taken, and the hearing was so much improved that the watch was heard about four inches from the left auricle. He remained under treatment for a few days, and then returned to Waterbury, and has been under the careful and able observation of Dr. North, who has applied remedies of various kinds to the left meatus, the patient keeping the Eustachian tubes permeable by means of gargles and Politzer's apparatus. The last time I saw the patient was in October of this year (1865), when the following note was made: "He has had no attack of pain in the ear since the first date. There is still a considerable discharge of pus from each ear. He hears ordinary conversation well, and the watch ten inches from his left ear, and two inches on the right; a gain of one inch and nine inches respectively." The bony growth on the right side has not increased any, and that on the left is now smooth, and has a somewhat glistening appearance. June, 1868, patient still remains free from any disturbing symptoms.

Case IV.—Woman, æt. 27, at the N. Y. Eye and Ear Infirmary. No reliable history could be obtained from the patient as to her ears, except that she had been occasionally hard of hearing for some years. She was quite sure that she never had had a discharge from the ears; was in good general health, and had always been so. She could hear the watch two feet from the left auricle, and twelve inches from the right. The left membrana tympani showed evidences of previous inflammatory action, there being thickening of its mucous and fibrous layers. There is a bony enlargement of the posterior wall of the right meatus, so large as to prevent any view of the membrana tympani. The patient was seen but a few times, not continuing under treatment.

Case V.—Mr. W., æt. 23, a patient sent to me by Prof. Fordyce Barker, of this city. Had scarlet fever when young; and since that time has suffered from purulent discharge from the ear, and has been quite deaf. General health is excellent; no gouty, rheumatic, or other diathesis. Hears ordinary conversation very near at hand with

very great difficulty. The watch is heard when pressed upon right meatus; not at all on left. A gelatinous polypus was found attached to the hypertrophic posterior wall of the auditory canal. It was removed by torsion and nitric acid, applied to its roots. On left side there is a pedunculated, bony growth arising from the posterior wall, nearly occluding caliber of canal. Naso-pharyngeal catarrh. June, 1868, patient has been under observation since first date. Now hears conversation much better, watch at a distance varying from one to two inches, on right side. Secretion of pus, which, when patient was first seen was profuse, is now slight. Growths remain the same.

REMARKS.—As has been indicated in the respective histories, these growths were rather general enlargements of the periosteum, and of the bone structure immediately beneath, than tumors—true exostoses. Their nature seemed to be inflammatory, or, rather, hypertrophic. Perhaps all the similar growths recorded in the literature of aural surgery are of this character, i. e., morbid growths consequent on local irritation; the irritating cause in these cases, with one exception, Case IV, being clearly ascertained to be the contact of pus passing from the middle ear. The process in its inception was probably a periostitis, which may exist independently of an dyscrasia. Mr. Toynbee details nine cases in his well known work on the Diseases of the Ear, and remarks that "they seem to be the result of a rheumatic or gouty diathesis." This certainly cannot be said of the cases here given; and a careful examination of the histories of Mr. Toynbee's cases has caused considerable doubt to the present writer, as to whether they, too, were not rather to be ascribed to local inflammatory action than to a diathesis. Virchow's views as to the etiology of bony growths in general may here be given: "With respect to the etiology of the hyperplastic osteomata, the fact cannot be lost sight of that local impressions were, in very many cases, the exciting cause. According to experience, entirely positive and generally very rude mechanical injuries form the ordinary starting point of the morbid process; and, as has been already shown, this process presents itself substantially as an irritative one, often even as inflammatory, so that a boundary between bony products of inflammation and osteomata cannot generally be drawn."[1]

[1] Die Krankhaften Geschwulste, II Band., I Halfte, p. 73, et seq., passim.

"Some have, indeed, educed the frequent cases where certain constitutional diseases, especially rheumatism, arthritis, syphilis, scorbutus rachites, have produced bony tumors, as being something opposed to these local causes. Undoubtedly the field of these conditions was formerly too widely extended; and we may say that scorbutus is now almost entirely excluded from the list of causes, and that the gouty enlargements of bone are no growths (gewachse), but only deposits (ablagerungen). But we may not deny the influence of the other so called dyscrasia, especially of the rheumatic, syphilitic, and rachitic conditions. In spite of this, the influence must not be over estimated," etc.

"As to rheumatism and syphilis, we may not here even content ourselves with assigning constitutional causes; for the affection of one single bone must always be considered as dependent on a local impression."

As also interesting in considering this subject of bony growths, parts of an article by Professor Welcker, of Halle, referred to by the author, are here reproduced:[1]

"Professor Seligmann has made the interesting statement that, in the various American skulls found in different collections, skulls known as Titicaians, Huankas, Aymaras, and which have been elongated by pressure during infancy, exostoses in the external auditory canal are very common. He says, of six skulls which I have, up to this time, examined, five have such exostoses. In the very similarly deformed so called Avarian skulls, exostoses did not exist. This is certainly a remarkable phenomenon, and may well justify the inquiry; are these exostoses a peculiarity of race, or are they a certain production of an injurious cause, especially efficacious in this race? My honored friend, Professor Seligmann, has promised us a closer examination as to this. Still, I do not think that he will be able to maintain his present opinion, which is, that this abnormity is found only in the class of skulls above named. My memorandum of the examination of a North American Fox Indian, No. 229 of the Heidelberg collection, reads, 'exostoses in the auditory canal.' Of nine skulls of Marquesan Islanders, which neither belong to the American race nor exhibit a trace of artificial deformity, I found aural exostoses in two, one of which was in an advanced stage of development. To this must be added, that in the civilized nations of Europe these exostoses

[1] Archiv. für Ohrenheilkunde, I Band., III Hälfte, 1864.

are by no means as seldom as the writers on aural surgery indicate; and I believe, after thoroughly reviewing the collection described by C. O. Weber (Die Exostosen und Enchondrome, Bonn, 1856), that the meatus auditorius externus may be designated as a peculiarly favorite position for these growths. The appearance of these exostoses, as one of the well known consequences of disease, is by no means the view of Professor S.; but he regards them as peculiar to the Titicaian skulls. But I do not agree with him in thinking that the exostoses of that foreign race should be considered as anything different from the same familiar condition appearing on the German skull, and recognized by aural surgeons. We are, however, indebted to the studies of Professor Seligmann for the knowledge of the certainly not uninteresting fact, that these exostoses occur much more frequently in the transatlantic skulls than in those of the population of our own continent. Thus, in the examination of the skulls of foreign races, I have found the three before named cases of aural exostoses, while in the Caucasian skulls, which I have examined in a much larger number, I have not as yet met with a single one. St. J. R.)

LECTURE X.

INFLAMMATION AND INJURIES OF THE MEMBRANA TYMPANI.

Affections of the membrana tympani very common, but seldom occurring alone and uncomplicated; acute and chronic myringitis; bad effect of cold upon the ear; lacerations and perforations of the membrana tympani; several cases of fracture of the handle of the malleus.

GENTLEMEN: Affections of the membrana tympani occur very frequently. This we would infer from its position and anatomical construction. It forms the partition wall between the auditory canal and cavity of the tympanum. It can, therefore, be considered as belonging to both parts; and it takes part in the affections of each of them. Moreover, tissue from either side is extended upon its surface; on the outer side from the auditory canal, a covering of skin and epidermis, and on the inner a continuation of the mucous membrane of the cavity of the tympanum, or middle ear. All the vessels and nerves of the membrane are found in these two layers, while the middle fibrous layer has neither. It is thus evident that the membrane will almost always participate in the affections of the adjoining parts. We should also remember that three of the most important tissues of the animal system are found in this membrane, integument, mucous membrane, and fibrous tissue. Hence pathological changes are very common in the part.

Although affections of the membrana tympani are very

frequent, exact and unprejudiced observation must show that they seldom occur alone, and uncomplicated with an affection of another part of the ear. The membrana tympani is nourished by the same blood vessels and nerves that supply the cavity of the tympanum and the auditory canal. It thus really only forms a part of these divisions of the ear. In any affection of the adjacent parts therefore, the drum will almost always be involved, while its independent affections must react upon these adjacent parts, if the morbid process be severe.

This extension to the other parts will be more apt to occur if the affection is attended by suppuration, the pus acting as an irritant upon these structures on account of the smallness of the space involved. Since this reciprocal relation between the membrana tympani and its adjacent parts exists in acute affections, we are much less able, in the very chronic suppurative processes, to determine whether it was an inflammation of the auditory canal or of the cavity of the tympanum, which first existed and subsequently involved the membrana tympani.

This view, that genuine and uncomplicated inflammations of the membrana tympani are comparatively rare, is contrary to the one commonly accepted, and to the teachings of writers on aural medicine and surgery. I am constrained to this opinion, however, from observation on a considerable number of patients, made, so far as I am able, in an impartial manner. The anatomy of the parts involved, as well as the history of the cases in the text books, described under the head of inflammation of the membrana tympani, when they are carefully examined, also sustain this view. If we read these critically, we see that the symptoms and the objective appearances of the acute inflammation of the membrana tympani are generally those of a diffuse inflammation of the auditory canal, or of an acute or purulent catarrh of the cavity of the tympanum, in

either of which processes, it is easy to see that the drum of the ear will readily enough be involved. We can by no means believe, from the descriptions, that the membrana tympani was usually first, and attacked independently. Just so we should call the chronic inflammation of the membrana tympani of various authors chronic catarrh of the cavity of the tympanum, with consecutive changes and inflammation of the membrana tympani.

Myringitis[1] may occur in an acute and chronic form. The cases which I have observed in the acute form always occurred suddenly and in the night, generally after exposure to cold; often after cold bathing. They were accompanied by severe pain, which increased in placing the affected ear on the pillow. There is a feeling of fullness, insensibility, and heaviness, and almost always a very great noise in the ear. These symptoms, with unfrequent interruptions, last from twelve hours to three days, and cease so soon as the auditory canal becomes moist, and a gradually developed discharge from the ear begins. In one case the pain ceased after a sudden attack of hæmorrhage from the ear, which, according to the patient's account, was to the extent of a table spoonful of blood.

Objective Symptoms.—In the beginning, hyperæmia of the membrana tympani is seen. It appears as if it were artificially injected. There are not only some large vessels running along the handle of the malleus from above downwards, to the central and most concave portion of the membrana tympani, called the umbo, and radiating from this point, but there are also vessels on the periphery, running to the center, and connected on all sides with vessels of the canal. As a consequence of the infiltration of the epidermis, the shining appearance of the membrana

[1] So named by Linke and Wilde.

tympani is soon lost, and its external surface becomes dull, like glass that has been breathed upon.

The handle of the malleus, which, in a normal condition, may be seen as a yellowish white stripe, in the middle of the membrana tympani, is not to be seen, while, at the same time, the membrane appears somewhat flattened. In the later stages the epidermis is lifted up in little lumps or lamellæ; and the corium, or true skin, is red, swollen, relaxed, and covered with a thin secretion. The auditory canal, which, in the beginning of the attack, remains entirely unaffected, becomes injected very quickly in the neighborhood of the drum, so that the usually well defined boundary between the two parts is obscured. In some cases of this nature which I observed, the process went on to ulceration and perforation of the membrana tympani. In one case a kind of sub-cutaneous ecchymosis occurred. In another I observed on the posterior and upper edge of the membrana tympani a swelling about as large as a pea, yellow, soft, and tender, touching which with a probe caused severe pain. This little elevation in the membrana tympani, protruding its surface into the auditory passage, I regarded as an abscess formed between its layers.[1] It decreased gradually with the subsidence of the inflammatory process.

Under favorable circumstances, the generally slight amount of discharge from the ear gradually ceases, the redness and infiltration disappear, and the membrane is again covered with epidermis. It always, however, remains for some time dull and flat in appearance. The handle of the malleus, so distinctly to be seen in a normal condition, is not now so plain, in consequence of the thickness of the layer of cutis. We are therefore able to recognize an

[1] Wilde observed such small circumscribed depositions of pus between the layers of the membrana tympani in ten cases. These interlammellar abscesses are not very rare, according to recent observations.

infiltration into the membrane long after its occurrence. So far as I have observed, these cases are apt to occur in one ear alone.

Since acute inflammations of the auditory canal and of the membrana tympani occur particularly often after cold bathing, every one should protect the ear while in the water by some sort of covering, or by a bit of cotton in the meatus. These precautionary measures are doubly necessary when the water employed is cold, or in sea bathing, where the force of the waves and the salty constituents come into consideration.

Besides this precaution, all fluids that are dropped or syringed into the ear should be previously warmed, lest their use produce an unpleasant or even injurious effect. Cold injections of the ear may easily cause vertigo and fainting, while filling the ear with warm water generally causes an extremely pleasant sensation, and is one of the most efficacious remedies for pain in the part. It is also very necessary to carefully stop the ear of the patient when iced applications are made upon the head; since the dropping of cold water into the ear not unfrequently adds a second and very painful affection to the original disease. An inflammation of the ear, arising in this way, might easily give a false idea as to the nature of the disease, since it would certainly be the last thing believed, that the suddenly occurring aural affection depended upon the water that had entered the ear.

Wreden[1] has observed several cases of inflammation of the membrana tympana caused by the growth of fungi, *asperquillus glaucus*. He calls the affection *myringomykosis*, or *myringitis parasitica*. Recent observations show that such fungoid deposits upon the outer surface of the drum are not rare.

[1] Archiv. für Ohrenheilkunde, III, B. I.

Chronic Myringitis.—This is more common than the acute form. It is less severe, however, than other affections, and there is a very slight amount of suppuration, since severe inflammations of this kind either involve the auditory canal, so that the affection resembles a chronic otitis externa, or they extend to the middle ear through an ulceration and perforation of the membrana tympani; and then, of course, we are dealing with a chronic otitis interna.

Simple, uncomplicated, chronic inflammation of the membrana tympani, as a rule, occurs with such slight subjective symptoms, that the attention of the patient is first called to the affection by some slight discharge from the ear, or moisture on the pillow. An annoying itching sensation in the ear is occasionally complained of; but the pain is usually so slight and evanescent, perhaps after some sort of injury to the ear, and the affection disturbs the patient so little, especially if one ear alone be involved, that it often exists for years before medical advice is sought.

Objective Symptoms.—On examination of the external auditory passage, we find no changes, except a partial softening of the epithelial covering in the immediate neighborbood of the membrana tympani, in consequence of its contact with the secretion. The secretion is generally small in quantity, quite consistent, with an offensive smell. It covers the membrana tympani, and always appears on the adjacent parts in the form of crusts. The drum, even when there is no secretion from it, always appears dull and hazy, so that we can only just make out the handle of the malleus, and its short process. The epidermis—but only in certain points, generally posteriorly and above—is removed; and these points are red and swollen. The membrane appears variously yellow or grey in color, thickened, with varicose vessels running over it, which are gene-

rally found on the periphery. Not unfrequently we find a partial sinking inwards of the membrane, with irregularities in its curvature and plane. These indicate adhesions with portions of the cavity of the tympanum. Partial calcareous and exudative depositions are also not a rare result of inflammations of the membrana tympani. Polypi may be developed from the small swellings, spoken of above, and the purulent discharge is often kept up by these alone.

Prognosis.—In the acute form this is very good, if the patient be properly treated. The purulent discharge soon ceases, and the pain does not return. Recent perforations heal quite readily, when there is no purulent catarrh of the middle ear connected with it. The thickening of the membrane also gradually disappears, and the hearing is restored. Under favorable circumstances scarcely a vestige of the disease remains. On the other hand, if the disease be neglected, if it be treated with poultices, or with irritating ear drops, the membrana tympani will remain perforated, and the otorrhœa may easily become chronic. The purulent inflammation will extend itself more and more on all the other parts, and all the consequences of a chronic otitis may develop themselves from a simple myringitis. We shall see further on, in the course of these lectures, what an importance chronic otitis has, for health and life.

In chronic myringitis the prognosis is much less favorable; for it is only by treatments, continued for years perhaps, that we are able to restrain the secretion, and even then there will exist a certain tendency to relapse. Furthermore, the pathological changes, especially the thickening of the membrana tympani, are generally so great, as not to lead us to expect much of an improvement in the hearing. In individual cases, however, great patience in the treatment produces very good results.

Treatment.—There is very little to say here, since the treatment is very like that of otitis externa. In acute myringitis, in order to guard against the danger of perforation of the membrana tympani, in connection with local blood-letting, you will give cathartic doses of calomel with jalap. (It may be considered extremely probable that a mild cathartic will do better than the one here suggested. St. J. R.) Poultices should not be employed; but warm water may be slowly and carefully poured into the ear, according as there is pain felt in the part. Since we have learned from experience that perforation of the membrana tympani is particularly apt to occur during vigorous expiratory efforts, we should always warn the patient not to blow his nose very vigorously, and to avoid all agents which may cause sneezing.

Very recently, *Schwartze*[1] has urgently recommended "paracentesis of the membrana tympani," in certain cases of acute inflammation of the membrana tympani, where a very great swelling appeared in the usually dark bluish red tissue. This swelling is greatest at the posterior and upper quadrant of the membrana tympani; and the pain in the ear is not usually relieved by other remedies.

Paracentesis acts in these cases by relaxing the tissue, and perhaps by direct depletion of the vessels of the membrana tympani. It relieves the pain and materially shortens the process, as repeated observations show. The opening very soon closes again, and ulceration of the drum never occurs. (This little operation is nothing more than evacuating an abscess, and is certainly indicated in the acute cases, where very considerable bulging outwards of the membrana tympani is observed. With the present means of examination, it is not at all difficult to accurately determine the existence and situation of any such swelling. St. J. R.)

[1] Archiv. für Ohrenheilkunde, B. II, S. 266.

If exudation has occurred, you should daily cleanse the ear by careful syringing, and afterwards drop in a mild astringent. In cases of long duration of the treatment, when the discharge becomes chronic, the remedies should be often varied. Under this treatment the purulent discharge will cease, and a quite extensive perforation will heal. For the remaining thickening of the membrana tympani, tincture of iodine, or an iodurated salve should be rubbed behind the ear. If there is no purulent discharge present, and there has been none for some time, we may employ irritating agents with which to pencil the drum, as well as irritating drops in the ear. I have sometimes seen good results in superficial thickening of the membrana tympani from strong solutions of the bi-chloride of mercury, from one to four grains to the ounce. The pain of such an application is sometimes very severe, and we must be very careful that none of the fluid be collected together on the anterior and lower portion of the membrana tympani, where it would readily perforate it; and you must never undertake such a treatment when you cannot have the patient under your eye.

Any portions which may be particularly swelled may be pencilled with strong solutions of sulphate of zinc, with tincture *ferri sesquichlorati*, or with dilute or concentrated acetic acid.

cavity of the tympanum and pass on to a consideration of the injuries of the membrane. These are quite common, as we would infer from the delicacy of structure of the membrane, and its exposed position. Ruptures of the membrane are the injuries that usually occur. They result from too strong a pressure of air acting upon the drum from without, whether in consequence of a box on the ear, etc., or from explosions occurring near the ear. I have seen old and recent ruptures of the membrana tympani, the latter often accompanied by otorrhœa, which were owing to a box on the ear received at school. A short time ago a student presented himself to me, who had received a slap on the ear in a joke, and since which he had felt a slight pain in the ear. No discharge had occurred. The membrana tympani showed a rupture parallel with the handle of the malleus, running its whole length. The edges of the wound were reddened, and covered with blood. The posterior half was greatly injected, the anterior normal, and the hearing was considerably diminished.

The attention of parents and teachers should be earnestly called to the fact, that the vicinity of the ear is a very inappropriate part for the application of corporeal punishment. They should be told how easily a rupture or inflammation of the drum may be caused by a blow upon the auricle. Ruptures of the membrana tympani may also occur from striking the head upon the water when bathing.

It has been denied, but improperly, that rupture of the membrana tympani may occur from the explosion of cannon. I have seen one recent case, and several old ones, which, without doubt, were thus caused, where linear perforations or cicatrices were to be seen. The course of these is almost always posterior to, and parallel with the handle of the malleus. Such cicatrices appear as greyish white, sometimes slightly bronzed lines. Very many cases of deafness occur among artillerists who have served a very

long time; and they always date it, to a moment, when standing near a cannon in the act of discharging, they felt a heavy blow and pain in the ear turned towards the cannon. Blood is said to usually escape. In some cases I found the impairment of hearing so great, as to imply that still more serious injuries had taken place.

When the affection is only on one side, an examination with the tuning fork will decide whether any more than the peripheral parts of the organ have suffered harm.

We may guard against injury to the membrana tympani when great concussions of the atmosphere are taking place, by stopping up the ears, drawing the shoulder up against the ear most in danger, and particularly by practicing the method of inflating the middle ear, known as Valsalva's. This method consists in making a powerful expiration, with the mouth and nostrils closed. These methods are certainly more reliable than the one traditionally employed among artillerists, i. e., merely opening the mouth. The tension on the pharyngeal mucous membrane that is produced in drawing back the jaw, can certainly open the pharyngeal orifice of the Eustachian tube but very little.

It is evident from the nature of things, that every sudden condensation of the external air must act more powerfully if the tube be impermeable upon a membrana tympani whose excursive power is impaired, and also upon the deeper parts, the contents of the cavity of the tympanum and of the labyrinth, than when the air in the cavity of the tympanum can make its way out through the Eustachian tube.

In a great number of cases, which I have examined soon after such an accident as rupture of the drum has occurred, there has been severe pharyngeal catarrh with impermeability of the affected tube.

(I once saw a case where rupture of the drum was caused from the explosion of a pistol in the immediate vicinity of

the patient's ear. She was unaware that the pistol was about to be fired. It will be observed that comparatively few ruptures occur where the explosion is expected, although singing in the ears is always produced. It is a remarkable fact that comparatively few cases of rupture of the drum occurring during the great artillery duels of our late civil war, have come under the observation of surgeons, or at least that very few have been reported. I have seen a few cases of deafness resulting from concussion of the contents of the labyrinth, from the firing of artillery, especially when soldiers in the front rank lay down while cannon were fired immediately over their heads. St. J. R.)

It is well known that the membrana tympani is often ruptured in the case of fracture of the skull. Rupture also occurs in whooping cough, with or without hemorrhage from the ears. Wilde relates two cases where it occurred after suicidal hanging. But this is not always the case when death occurs by hanging, as was shown by one case that I examined, where no such injury occurred.

Perforation of the membrana tympani is sometimes caused by the introduction of sharp objects, in order to relieve itching sensations in the part. Women not unfrequently use their knitting needles for this purpose. I have seen several cases of perforation of the membrana tympani thus induced.

Careless probing the ear, on the part of an examining surgeon, may also produce perforation of the membrana tympani. You should never introduce a probe any further into the ear than you can see at the same time, so that the eye may guide the hand. The disregardance of this precaution has caused much harm to result from the probing the ear. It is sometimes practised in order to determine the existence of caries, or of a perforation, and then has itself caused the latter. In the greater number of cases

in which the probe is still used, the eye, i. e., with a proper examination and good illumination, furnishes much more exact conclusions as to the condition of the parts than the sensation communicated to the fingers through the probe. (I have observed two cases where the membrana tympani was ruptured by the examining physician, who attempted to learn if the impaired hearing was caused by hardened wax. St. J. R.) I once observed a case of perforation of the membrana tympani from a blade of straw. It occurred to a school teacher in the country, whom I often saw on account of another affection of the ear. As this man was going up into his hay loft on a ladder he hit his head against a bundle of straw, and one of the blades entered his ear. This caused such fearful pain that he almost fainted, and he could scarcely keep himself on the ladder. He suffered for about half a day from severe pain in the ear, which then left him.

The impairment of hearing already existing was not increased by this accident; and he thought that the sissing sound in the ear, which had troubled him for years, had become somewhat less since then. About two weeks after I found a small black triangular spot in the posterior and lower part of the membrana tympani, which resembled a perforation closed by coagulated blood. I saw a similar case in a farmer, who got a blade of straw in his ear, while he was unloading the bundle from a wagon. He fainted from the effect of the injury.

Treatment.—Especial treatment will scarcely be necessary in recent and simple cases of this kind. The drum readily heals; its regenerative power being very large. *Magnus*[1] relates a case where a gardener got a twig of birch into his ear, which was not removed until three days later. The membrana tympani was extensively torn, and a severe suppura-

[1] Magnus, Archiv. für Ohrenheilkunde, I, B. I, S. 43.

tive inflammation had occurred. In spite of this, in three weeks the hearing power and membrana tympani were normal. It was only on the employment of the Valsalvian experiment that the bulging forward of a portion of the drum showed where the rupture had occurred. After injuries of this kind, we should close the ear lightly with cotton, and guard it from all injurious influences.

Cases of concussion from explosions, such as occur to artillerists, where severe injuries, hemorrhages, and lacerations of the deeper parts have resulted, demand of course careful observation, and treatment according to general therapeutic principles. We shall speak of this subject again when we come to the subject of nervous deafness.

Fracture of the Handle of the Malleus.—To this place belong the few cases which have been observed of fracture of the handle of the malleus. *Meniere*[1] speaks of such a case occurring in a gardener, who accidentally had a twig of a pear tree thrust in his ear. A very extensive laceration of the membrana tympani took place, and the little bones of the ear could be plainly seen, and their movements distinguished. This remarkable injury healed of itself, without any especial treatment. I myself saw a case of united fracture of the handle of the malleus. A wine merchant thrust a pen handle, which he held in his hand, into his ear, in consequence of knocking his elbow against an open door. The severe pain caused him to faint, and he did not recover for some minutes. Cold water was immediately put in the ear, and he could not tell whether blood flowed from it or not. After that time he heard poorly from the injured ear, and suffered from noises in it, more especially if he lay on that side. When I saw the case, one year later, the peculiar slanting position of the handle of the malleus was very striking; it also appeared

[1] Gazette Médicale de Paris, 1856, No. 50.

uncommonly thick and prominent at a point immediately under the processus brevis, and from this point out turned, as it were, on its axis. In short, it resembled a case of united fracture of the handle of the malleus. *Hyrtl*[1] described such a united fracture, which he found in the ear of a prairie dog (*Arctomys ludovicianus*), which had a very similar appearance; and was, also, as in the above case, immediately under the neck of the malleus. He states that such an injury is not remarkable as occurring in this animal, since it is a relative to our marmot (mole), lives in caves or holes under the ground, and has a membrana tympani that is very superficially situated, in consequence of the shortness of the auditory canal.[2] (Professor Joseph Hyrtl, teacher of anatomy in the Vienna University, has a very extensive collection of the little bones of hearing, and of the internal ear of the mammalia.

(My friend, Dr. *R. F. Weir*, surgeon to the New York Eye and Ear Infirmary, has kindly furnished me with the notes of a case of ununited fracture of the handle of the malleus, that came under his observation at that Institution. The patient was an Irish laborer. Four months before he was seen by Dr. Weir he received a fall, of 15 feet, which caused unconsciousness and bleeding from the ear. He had pain in his ear for 16 hours after, running along the forehead to the ear. Was laid up for a month, and then pain passed away. The tinnitus aurium is very great. On examining the right ear, the handle of the malleus seems to have been fractured just below the short process, where an irregularity is seen, and the lower fragment moves with great freedom upon the upper. The irregularity disappears after inflating the ear by the Valsalvian method. On the posterior part of the drum a patch

[1] Wiener Medicinischer Wochenschrift, No. ij, 1862.

[2] *Toynbee* only mentions such a case of fracture without a history. Catalogue of Preparation Illustrative of Diseases of the Ear: London, p. 68.

of increased whiteness is seen, and possibly it indicates the site of a rupture. In ten or fifteen minutes afterwards the displacement of the bone again occurs." St. J. R.)

LECTURE XI.

ANATOMY OF THE MIDDLE EAR.

The cavity of the tympanum; general view; outer wall, or membrana tympani; floor, or wall of the jugular fossa; roof, or wall of the membranes of the brain; (fisssura petro-squamosa;) inner wall, or wall of the labyrinth; (fenestræ ovalis and rotunda; promontory; carotid artery and venous sinus; the relations of the facial nerve to the cavity of the tympanum; muscles of the cavity; projection inward of one of the semi-circular canals;) posterior wall, or wall of the mastoid process; opening of the Eustachian tube into the cavity of the tympanum; topographical view; the different diameters of the cavity of the tympanum; its mucous membrane in the adult and the fœtus.

GENTLEMEN: Now that we have considered the diseases of the external ear, we turn to those of the middle part of the organ of hearing. We may at first more exactly study the place in which these affections are developed, and run their course; and this leads us to a study of the anatomy of the middle ear.

The most important part of this division of the auditory apparatus is the cavity of the tympanum; a space between the membrana tympani and the labyrinth, filled with air, in which are found the three *ossicula auditus*, forming an articulated and variously tense connecting chain between the outer and inner ear.

On practical grounds, we must consider as especially important, the relations of this cavity to the brain and its

membranes, to the internal carotid artery, internal jugular vein, and finally to the facial nerve. There are also to be mentioned the two muscles of these ossicula, and the openings, or fenestræ, leading to the labyrinth.

Since it can be demonstrated that the greater number of pathological changes occurring in the ear are localized in the cavity of the tympanum, it is very important for the physician, that he have more than a general idea of the anatomy of this cavity, and of its relations to the adjacent structures, that have just been mentioned. The apparent difficulty of the subject lies in the facts, that the cavity is very small, the noteworthy points very many, and that we seldom have an opportunity of an actual view of the parts.

It will be best for us to notice only the most important of these parts, describing the different walls in their order. An indication of these at this juncture may perhaps facilitate our understanding of the subject.

The cavity of the tympanum may represent an irregular space, having six sides:

I. Outer wall, or membrana tympani.
II. Inner wall, or wall of the labyrinth.
III. Upper wall, or roof; the wall of the cerebral membranes.
IV. Lower wall, or floor; wall of the jugular vein.
V. Wall of the mastoid cells, passing anteriorly into the
VI. Eustachian tube.

We have already studied the outer wall, or side, or membrana tympani, it being chiefly formed of this membrane, with the two *ossicula auditus*,—the malleus whose handle is inserted in its layers, and the incus articulating with the latter. The long process of the incus lies parallel to the handle of the malleus, and behind it, but does not extend so far down.

In the fœtus and the newly born, we find a vascular fold of mucous membrane extending the whole length between the process of the incus and the handle of the malleus. When this connection of these two parts is found in adults, it must be considered as pathological. It is, however, possible that this fœtal condition does not always disappear completely or at all.

By removing the incus, we get a view of the whole of the posterior pocket or pouch of the membrana tympani. On the malleus, under the neck, we observe the insertion of the tendon of the tensor tympani muscle, and immediately above it the chorda tympani of the facial nerve, running under the long process of the incus, on the free margin of the posterior pocket of the membrana tympani. It crosses the neck of the malleus, and then, after assisting to form the anterior pocket, leaves the ear through the Glaserian fissure.

The most important part of the tendon of the tensor tympani, that is, the actually tendinous portion, is inserted close under the chorda tympani. A more delicate portion curves upwards and anteriorly along the free border of the anterior pocket. The muscle itself is surrounded by quite a thick envelope of connective tissue, in its osseous canal, which accompanies it like a sheath obliquely across the cavity of the tympanum. If we draw upon the muscle, besides the membrana tympani itself, chiefly its middle portion, the tendinous cord, extending over the cavity of the tympanum, also moves. A transverse section of this tendinous cord, even with slight magnifying power, shows that the thicker central tendinous mass is surrounded by a looser connective tisue, and that the two component parts are demarcated from each other by a distinct circular line.

The Glaserian fissure, lying close to the anterior border of the membrana tympani (called *fissura petro tympanica* by *Henle*), is one of those commissures which recalls the fact, that the temporal bone, in fœtal life, is made up of several independent bones. In a child, where a fissure-like gap, filled up by soft parts, still exists, this passage might

afford a way for the transition of an aural affection upon the articulation of the jaw.

An Italian anatomist, Dr. *Verga*,[1] very recently described a ligament that passes from the malleus obliquely upwards, and is inserted upon the inferior maxillary bone, as the *malleo-maxillary ligament*. In the human subject this is only easily recognized during the last five months of intra uterine life; and it is said to be a transition form of Meckel's cartilage. Even after birth, it does not always completely disappear, but gradually two distinct and well known parts are formed from it: From the part belonging to the cavity of the tympanum is formed the so called *anterior muscle of the malleus*, which in reality is a ligament. The remaining portion becomes thickened where it is attached to the lower jaw, and thus becomes the *internal lateral* ligament of the inferior maxilla.

It is important to observe what has already been alluded to, that the cellular cavities of the temporal bone are sometimes very large above and behind the head of the malleus, and thus extend for a distance beyond the membrana tympani into the bony tissue, which makes up the upper wall of the osseous auditory canal, and are connected (see figs. 1 and 2) to the cells of the mastoid process, which, as is well known, form the posterior wall of the osseous meatus.

Thus a way is made by which affections of the middle ear, and especially suppuration, not involving the membrana tympani, may extend externally and, breaking through the upper wall of the meatus, evacuate themselves in this part of the ear. Such secondary depositions of pus, under the integument of the upper part or roof of the meatus are not very rare. Deep abscesses of the ear may be sometimes evacuated externally by making an opening at this point.

The temporal bones of different individuals are so very different that no one pair can be found exactly like another.

[1] Journal de Méd., Chir. et Pharm: Bruxelles, 1854, p. 417. Archiv. für Ohrenheilkunde, II, S. 230.

The difference in structure is markedly seen on the lower wall, or floor, of the cavity of the tympanum. It is sometimes several lines in thickness, with long ridges and cellular depressions, composed in part of dense spongy, bony substance. Again, it is so thin as to be translucent; in which condition the internal jugular vein lies immediately under it.

This very frequent close contiguity of the jugular vein to the cavity of the tympanum highly deserves the attention of the practitioner as well as the anatomist. According to simple, physical laws, no portion of the cavity of the tympanum is so exposed to the influences of pus collected in it as the floor. A stagnation and deliquescence of the secretion collected here can the more readily occur, because the two openings by which it might be removed, —the point of entrance of the Eustachian tube and the opening into the mastoid cells,—lie somewhat higher.

Pus that becomes decomposed will necessarily irritate and macerate the mucous membrane, and subsequently the bone lying under, and thus cause inflammatory softening, and finally ulceration in this part. Caries of bone in the vicinity of a vein, such as the internal jugular, cannot be an indifferent matter, especially since the intervening osseous layer is very thin, and perforated by a delicate canal for the tympanic nerve (of the glosso-pharyngeus), and for a minute vessel.

Still more, without any previous disease, there may be fissures in the floor of the cavity of the tympanum.[1] In many animals the lower wall is always covered by membrane only. Thus the mucous membrane of the ear is in direct contact with the jugular vein, and there is no hindrance to a direct transmission of an inflammatory process from one part to the other. The contiguity of the jugular may also show how easy it is for vascular murmurs, occurring

[1] Toynbee's Catalogue, p. 44.

in anæmic persons for example, to be conducted to the ear, and be considered as originating there.

It should also be mentioned that the pneumo-gastric nerve, the glosso-pharyngeus, and accessorius all pass out of the cranium through the jugular foramen. The hypoglossal nerve also lies near the upper section of the jugular vein. Affections of these nerves and their sheaths, therefore, are very possible in connection with inflammations in this region, and especially from the pressure of a large thrombus in the vein.

The upper wall or roof of the cavity of the tympanum is covered on its upper surface by dura mater, and thus forms the partition wall between the cavity of the tympanum and the cranium. According to the observations as yet made, this wall, the *tegmen tympani*, is most frequently softened, carious, or perforated, in caries of the temporal bone. The undeniable connection between the ear and secondary cerebral disease has been here most often shown. Sometimes it is a purulent myringitis or encephalitis; but usually an abscess in the cerebral substance. In consequence of this very great practical importance of the roof of the cavity of the tympanum, many variations in development of this part become doubly worthy of notice. *Hyrtl* (professor of anatomy in Vienna), has recently called attention to several such cases.[2]

The roof of the cavity of the tympanum, or *tegmen tympani*, varies greatly in thickness in different subjects. It is frequently seen to be, not a dense, compact structure, but composed of smaller and larger cells; and it is often so thin as to be translucent, and may even contain variously sized perforations, which may be easily mistaken for losses of sub-

[1] Vide case of Beck, Deutsche Klinik, 1863, No. 48. Archiv. für Ohrenheilkunde, III, S. 67.

[2] Spontaneous dehiscence of the roof of the tympanum. Sitzung's Bencht der Wiener Academie, XXX, B. No. XVI.

stance produced by caries. On account of the contiguity of the dura mater, these abnormities may be very important as regards the health and life of an individual who suffers from an inflammation, or from suppuration in the cavity of the tympanum. In some not very rare cases of partial atrophy of the osseous part of the roof of the cavity of the tympanum, the mucous membrane and dura mater lie next to each other, without any intervening material; and thus there is no hindrance to the transition of an inflammation or suppurative process from one part to the other.

In addition to those cases of losses of substance in the roof of the cavity of the tympanum, reported by Hyrtl, the reader is referred to Toynbee's Catalogue, p. 42, where a number of such cases are given. *Andreas Retsius* has also reported some cases in Schmidt's Jahrbücher, 1859, No. 11, S. 153. Every anatomical collection of temporal bones will furnish evidence as to the frequency of this rarefaction.

This anomaly of development may make itself known in practice in an unpleasant way. If, for instance, we forced compressed air into such a cavity of the tympanum, or an irritating fluid, in the usual way, a direct irritation of the dura mater, or a lifting up of it, like a vesicle from the bone, that is, sub-meningeal emphysema, may occur. *Gruber*[1] observed this in some experiments upon the cadaver.

Luschka[2] compares these alterations and perforations on the petrous portion of the temporal bone to the *foveae glandulares* of the calvarium, which, as is well known, are produced by the Pacchionian bodies; He believes that these villous-like vegetations of the arachnoid may also produce these rarefying effects on the roof of the cavity of the tympanum by pressure. Excellent as this explanation may be for some cases, it does not do for all; because these rarefications of the bone are frequently found where the dura mater is entirely normal. The condition of the bony edges of such perforations sometimes causes us to think that a slowly acting pressure has been acting from within outward.

[1] Oestr. Zeitschrift für Prakt. Heilkunde, 1864, No. 3, S. 54.
[2] Virchow's Archiv. Bd. XVIII, 1860, S. 166.

There is another reason why the *tegmen tympani* should so frequently play such an important part in transferring an inflammation of the ear to the cerebrum. The petro-squamosal fissure is situated here. This is the fissure separating the squamous process from the petrous portion, through which, in the infant subject, the dura mater sends a very vascular process into the cavity of the tympanum, and along which, even in adults, a number of fine vessels, branches of the middle meningeal artery, pass from the dura mater into the middle ear.

This fissure is largest, of course, in the child; but a greater or less trace of its existence is always found in more developed subjects, and it is occasionally visible even in advanced age. This communication of the dura mater with the cavity of the tympanum explains the fact, that in the existence of hyperæmia of the middle ear on the dead subject, the vessels of the dura mater lying over it are frequently found enlarged and overloaded. This intimate nutritive connection between the mucous membrane of the middle ear and the dura mater may explain many symptoms, that we shall subsequently find to occur very often in inflammation of the cavity of the tympanum.

The inner wall of the cavity of the tympanum is perhaps the most important of all of them. This, on account of its relation to the inner ear, may be called the labyrinthine wall. It forms the boundary between the middle and inner ear, and the important parts composing this latter portion lie behind it. In the labyrinth wall are found the two openings, which connect the parts of the auditory apparatus that conduct the sound, and those which receive it. These openings are the fenestra ovalis and the fenestra rotunda; the former leading to the cochlea, the latter to the vestibule.

The fenestra ovalis, or the fenestra of the vestibule, should not be considered, as it generally seems to be, as a

simple opening in the wall, but it has some depth; it has a niche, if I may so express myself, which is filled for the most part by the base of the stapes bone. This vestibular fenestra is found at the base of a funnel-shaped opening, looking towards the cavity of the tympanum (pelvis ovalis), whose mucous membrane is very near to the sides of the stapes.

(This fissure or opening is produced by the prominence of the Fallopian canal, and the arch of the promontory.)

The labyrinth side of the fenestra ovalis is closed by the periosteum of the vestibule, which covers it, and thus forms the membrane of the fenestra ovalis. The base of the stapes is united to it: since its circumference is somewhat smaller than the fenestra itself, the outermost periphery remains open like a small seam, not being covered by the base of the stapes. This very small membranous ring around the base of the stapes, the enveloping membrane of the stapes,—also called annular ligament of the stapes,—we may best see by holding the labyrinth wall of the cavity of the tympanum, with the stapes in situ, towards the sunlight, and observing the base of the stapes from the vestibular side. It is better still to examine the parts under the microscope, by means of sun-light passing through them from beneath.—*Voltolini.*

Toynbee described a perfect articulation between the stapes and the fenestra ovalis, stapedio-vestibular articulation, with all the parts of such a joint, cartilage, ligament, and synovial fluid. He gives an exact description of this articulation in the Medical Times and Gazette (London), June 20, 1857: "In a recently removed ear the surface of the base of the stapes is smooth, and covered with a fine layer of cartilage. It is most abundant on the two extremities, from which, especially in young persons, enough may be removed for a microscopic examination. It consists of oval corpuscles, similar to those in ordinary articular cartilage, only very much smaller." Toynbee here really admits, by his own words, that this is no articulation in the real sense of the word; for then the two surfaces, lying opposite each

other, must be necessarily covered with cartilage. He also mentions the fact several times, that the surface of the fenestra ovalis is greater than that of the stapes, which fact excludes the idea of any such intimate connection as exists in an articulation. Nothing is said of an articular capsule. S. T. Sömmering described an articular capsule, which is said to unite the base of the stapes and the fenestra ovalis.—(De Corporis Humani Fabrica, T. II, p. 10.) *Voltolini* has recently shown that no true articulation really exists. Where there is no articulation, there can be no anchylosis. We can only speak of an immobility of the stapes, caused by a rigid pseudo membrane, which attaches it to the adjacent walls, or of a thickening and calcification of the membrane of the fenestra ovalis, such as we see in the membrane of the *fenestra rotunda*. Recent German anatomists do not accept either a layer of cartilage at the base of the stapes, or an articular capsule, while *A. Magnus* (Virchow's Archiv., 1861, B. XX, S. 125,) says that the surface of the base of the stapes, as well as the walls of the canal of the foramen ovalis, has a layer of the cartilage, which becomes less distinct in advanced life, and then only exhibits some indistinct cartilage corpuscles. *Magnus* also believes that the base of the stapes is by no means smaller than the surface of the *fenestra ovalis*, and that the latter is therefore completely filled up.

FIG. 14.

Superficial view of the labyrinth wall of the cavity of the tympanum: Pr, promontory, or most convex portion of the labyrinth wall. FR, entrance to the fenestra rotunda, or fenestra cochlea. M, st, stapes muscle in the bony pyramid, which is mostly opened; above, its tendon passing to the head of the stapes; the stapes in the fenestra ovalis, or fenestra of the vestibule. N, f, facial nerve up to its curvature into the Fallopian canal, whose lower half is laid open. C, *h, the horizontal or anterior semi-circular canal, opened at the most prominent part. M, t, t,*

tensor tympani muscle; a section of its tendon near the facial nerve. T, the uppermost portion of the osseous part of the Eustachian tube, interrupted by the carotid canal, which is laid open. C, i, internal carotid artery. F, j, fossa for the internal jugular vein.

The fenestra rotunda, or fenestra of the cochlea, lies under the fenestra ovalis. This also, like the fenestra of the vestibule, has a niche, a bony canal 1 mm. long. At its end is a membrane, the so-called second membrana tympani, which separates the tympanic orifice of the cochlea from the cavity of the tympanum. This canal passes obliquely from behind forward. Thus the membrane of the fenestra rotunda does not lie parallel with the membrana tympani, because this membrane, situated at the end of this depression, is not visible on the living subject, even when the whole membrana tympani is destroyed.

The membrane of the fenestra rotunda, with the canal leading to it, like all the parts of the cavity of the tympanum, is covered by mucous membrane. If this be thickened by catarrh of the middle ear, the passage to the membrane may easily be plugged up. The membrana tympani secondaria is also not unfrequently found thickened. Complete calcification of this membrane has also been observed.

It is plain that every morbid change that lessens or removes the elasticity of this delicate structure, must thereby exert an extremely disturbing influence upon the hearing, because the mobility of the stapes, and of its membrane, as well as every oscillation of the fluid between the two, —the fluid of the labyrinth,—is limited or destroyed. Abnormal conditions on the fenestra rotunda and its membrane seem to be very common in catarrh of the cavity of the tympanum. A pseudo-membrane is sometimes found to be stretched over the entrance of the niche of the fenestra rotunda, which, on superficial examination, may be mistaken for the membrana tympani secondaria.

Voltolini observed and reported several cases where the canal, leading to the membrane of the round fenestra, ran, not obliquely, but in a straight line; and thus the membrane became visible on the removal of the true membrana tympani.

This in an adult is certainly a very remarkable anomaly. This parallel position of the membrane with relation to the membrana tympani recalls the conditions in the human fœtus, and in some animals. In the fœtus of some three to four months, the fenestra rotunda lies nearly parallel to the membrana tympani. In the newly born, it is situated obliquely with relation to the membrane, and the niche is gradually turned more posteriorly towards the entrance to the mastoid cells. It is possible that in this case, as in that of the membrana tympani, under certain circumstances development is arrested in childhood.

Anteriorly, from these two fenestræ, and nearly opposite the membrana tympani, we find the promontory. This is a smooth and broad prominence, projecting somewhat into the cavity of the tympanum, behind which is situated the outermost turn of the cochlea. From this there goes a bony furrow, in which, under the mucous membrane, pass the tympanic nerve of the glosso-pharyngeus and several vessels. This groove or furrow varies in size in different individuals, like the various depressions and elevations of the cavity of the tympanum.

In front of the promontory, corresponding to the opening of the Eustachian tube into the cavity, lies the internal carotid artery. It is separated from the mucous membrane of the cavity of the tympanum only by a thin, porous, and often even defective bony layer. This always has irregularities on its side turned towards the cavity, so that retention and disintegration of purulent secretion may all the more readily occur there.

Caries in this wall of the carotid canal, which is besides perforated by numerous openings for vessels and nerves, not unfrequently occurs. This has led to the perforation of the arterial walls with subsequent fatal hemorrhage.

It should also be remembered that the inner side of the carotid canal, of the temporal bone, is covered by a reduplication of the dura mater, and that there is a venous space, a sinus of the *dura mater* between the artery and the bony wall, which is connected with the cavernous sinus of the *sella turcica* of the sphenoid; and, like this, it is crossed by a number of thread-like, and broad tendinous processes. As is well known, the adjacent venous sinuses, especially the transverse and superior petrosal, play a great part in the very frequent deleterious consequences of suppurative otitis. If nothing of this kind has as yet been recognized in the venous sinus of the carotid canal, it is probably because the attention of pathological anatomists has not yet been turned to this part. It is undeniable that this space is more exposed to an influence from an inflammatory collection in the cavity of the tympanum, on account of its position, than the sinuses, which have as yet been found to be so often affected. It should, therefore, be always carefully examined in such morbid processes.

This venous sinus in the carotid canal was described by *Rektörzik* in 1858.[1]

In skulls where the sinuses generally are filled with blood, the blood from this sinus runs out, and no inconsiderable quantity on opening the carotid canal. The sinus in question takes the greater part of its blood from the cellular blood passages, with which it is in direct connection. Some osseous veins also empty into it. Towards the entrance of the carotid canal, some small veins are formed from it, which terminate in several branches, and empty directly into the internal jugular vein.

Immediately above and behind the fenestra ovalis is a longish projection, covered only by a thin and translucent, sometimes even defective osseous layer. This is the Fallopian canal, with the facial nerve. It comes from behind,

[1] Sitzung's Bericht Wiener Akademie, XXXII, B. N. 23, S. 416.

and runs for some distance on the posterior portion of the labyrinth wall. It bends at nearly a right angle on this, and runs towards the opening of the auditory nerve. We also find the facial nerve running quite near the mucous membrane of the cavity of the tympanum on the posterior wall; but it is most intimately, and for the longest time, connected to the cavity of the tympanum on the labyrinth wall.

Anatomy explains to us why it is, that not only in caries of the bone, but also in simple inflammatory and hyperæmic conditions of the mucous membrane of the cavity of the tympanum, an affection of the facial nerve may occur. The facial nerve, during a portion of its course, is separated from the mucous membrane of the cavity of the tympanum only by a translucent bony layer, which is sometimes porous, or even deficient in some places, so that neurilema and mucous membrane are close to each other.[1] The stylo-mastoid artery, which supplies the greater part of the mucous membrane of the middle ear, runs from the stylo-mastoid foramen in connection with the facial nerve in the Fallopian canal, and sends off branches to the envelope of this nerve, so that the two parts have a certain nutritive unity.

Wilde, of Dublin, believes that he has frequently observed an obliquity of one of the angles of the mouth in deaf persons when the muscles of the face are in action, and an irregular development of the naso-labial furrows of the two sides. It is certain that in diseases of the cavity of the tympanum, the facial is very often found to be involved if close observation be made, It is also certain that a great deal of the so called rheumatic paralysis of the facial nerve is connected with affections of the ear, or proceeds from it.

[1] *Henle*, Handbuch der Anatomie, S. 147, states that there is almost always an oval opening above the fenestra of the vestibule, which is only covered by fibrous membrane. According to *Joseph*, the Fallopian canal is membranous until the fourth fœtal month, on the side towards the cavity of the tympanum.

The stapedius muscle is between the entrance to the fenestra rotunda and the Fallopian canal, running concentrically with the latter. This is the smallest muscle of the human body. It is enclosed in a scarcely developed osseous papilla, so that only its tendon, reaching to the head of the stapes, lies freely in the cavity of the tympanum.

The second internal muscle of the ear, the tensor tympani, passes above the Eustachian tube, running in the same direction with it, anteriorly into the cavity of the tympanum, and there runs on the uppermost part of the labyrinth wall very near to the roof, or tegmen tympani. Immediately in front of, and above the pelvis ovalis it becomes a tendon, which leaves the belly of the muscle at an obtuse angle, and passes obliquely over the cavity of the tympanum to be inserted on the malleus, as has already been described. This muscle lies in a bony canal that is sometimes half closed, but oftener completely so;[1] so that in the latter case the tensor tympani is as completely surrounded by bony substance as its partner, the stapedius.

Behind the facial nerve, about on a level with the fenestra ovalis, that is, in the uppermost and most posterior portion of the labyrinth wall, the anterior or horizontal semicircular canal curves over, having the vertex of the curvature in the cavity of the tympanum. It may be recognized by the marked whiteness and smoothness of its compact osseous material.

There have been several cases observed where caries at this point opened the semi-circular canal, so that the suppurative inflammation passed out of the cavity of the tympanum into the vestibule, and passing into the cribriform bony camellæ, through which the twigs of the auditory nerve pass, was continued into the *meatus auditorius internus*,

[1] Vide Ludw. Mayer Studien über die Anatomie des Canalis Eustachii, München, 1866, S. 34–37.

by which all the requirements for an inflammation of the meninges of the brain were fulfilled.

Since, in such a transference of a suppurative inflammation from the cavity of the tympanum to the labyrinth,—whether by the destruction of the horizontal semi-circular canal or through a perforation of the fenestra rotunda or ovalis,—the petrous portion of the temporal bone may possibly bear no evidence of morbid change, even after the removal of the dura mater; and since the roof of the cavity is not involved in such an affection, the true connection may be easily overlooked, and the meningitis may be mistaken for the primary idiopathic affection, when it is really an otitis. We should, therefore, be on our guard if we observe even a very slight amount of pus in the internal meatus, and break open the labyrinth from above, where the distinct traces of inflammation will show the true state of things.

Mastoid Cells.—The opening of the mastoid cells is found on the posterior wall. This opening is very often divided into several. These lead into a hollow space, which is developed in childhood and makes up the upper or horizontal part of the mastoid process. The mastoid cells, like the opening that leads to them, lie close under the roof of the cavity of the tympanum.

Eustachian Tube.—About on the same level, but on the anterior extremity, the Eustachian tube opens into the cavity of the tympanum. This opening, or *ostium tympanicum*, lies in the upper third of the cavity of the tympanum, and exactly opposite the opening into the mastoid cells. A probe passed through the tube and cavity of the tympanum will finally pass into these cells. The same thing will occur if fluids are injected, if the injection be done with sufficient force, and if they are pressed forward in such a quantity that they do not vaporize before reaching the point desired.

Topography of the Cavity of the Tympanum.—We may finally consider the topography of the cavity of the tympanum, in its relations to the membrana tympani, in order that we may have a clear idea as to which parts correspond to each other, and which we may see through a perforation of the membrana tympani, or, under certain circumstances, through the drum itself, when it is very transparent, or lies abnormally inwards.

The examination of a great number of macerated skulls shows that the outer opening of the cavity of the tympanum, which is usually closed by the membrana tympani, is just as differently shaped, as we have seen that it is from a section of the osseous meatus. We therefore may see in one skull parts of the labyrinth wall from without, which, on other skulls, are only seen partially or not at all. This is sometimes the case with the fenestra ovalis, for example, which, in some skulls, is situated in a position corresponding to the upper and posterior portion of the membrana tympani, but, as a rule, lies higher than this; so that it cannot be seen on the living subject from without, even when the membrana tympani is entirely gone.

The case is different with the stapes, which is fastened in the fenestra ovalis. Its position is somewhat sunken from above downwards, so that its head lies higher than the base. We may, therefore, not unfrequently get a view of a portion of this bone when there has been extensive loss of substance in the membrana tympani. Sometimes the head of the stapes, with the posterior side, is adherent to the unperforated membrana tympani, or lying so near to it that we may distinctly recognize this part of the bone on the posterior half, somewhat above the center of the membrane.

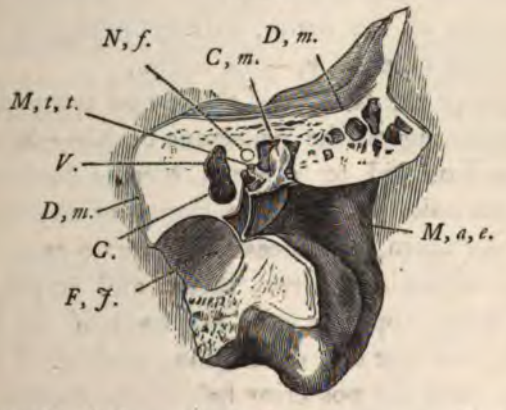
The fenestra rotunda corresponds to the lower and posterior portion of the drum. We have already seen that we are usually only able to recognize the entrance to its

niche, especially the anterior edge of it, but that we cannot see the membrana tympani secondaria. The promontory lies opposite the center and anterior and lower portion of the membrana tympani. It is very often completely seen, together with its vessels, when a portion of the membrana tympani is destroyed.

Measurements of the Cavity.—In order to properly estimate the pathological processes occurring in the cavity of the tympanum, and especially those of an adhesive nature, we must consider a little more exactly the different diameters of this space, and the distances at which the individual parts are from each other.

The cavity of the tympanum, viewed as a whole, and apart from the irregularities of the surfaces of its walls, may be compared to a low and very small hexahedron or cube. The horizontal diameter of this cavity is therefore the greatest. It is about 13 mm.

FIG. 15.



Vertical section of the cavity of the tympanum, continued through the membrana tympani and auditory canal: Left ear. M, a, e, bony external auditory canal; at its end the membrana tympani with the malleus. D, m, dura mater, covering over the upper wall of the cavity and of the meatus containing air cavities, as well as the whole of the inner surface

of the petrous portion of the temporal bone. C, m, head of the malleus, connected by its suspensory ligament to the roof of the cavity of the tympanum; to the median side of the malleus is the incus with its long or vertical process, articulating with the stapes; only the head of the stapes is to be seen. N, f, facial nerve, divided just after its right angular curvature. M, t, t, tensor tympani muscle, divided just before its tendon is given off; the latter is to be seen in its entire course from the labyrinth wall to the neck of the malleus. V, vestibule, with the orifice of a semicircular canal. C, cochlea, with the membrane of the fenestra rotunda; outwards (laterally) the promontory. F, J, fossa for the internal jugular vein, forming the very thin floor of the cavity.

The hight or the vertical diameter, anteriorly at the tympanic orifice of the tube, is only from 5 to 8 mm.; further back, at the malleus, it is 15 mm. The distance from the membrana tympani to the labyrinth wall is the least. At the mouth of the tube it is from 3 to 4½ mm.; but if we measure somewhat further back in the vertical plane of the malleus, we get only 2 mm. at the end of the handle of the malleus, which projects very much into the cavity of the tympanum. This is, of course, the most convex portion of the drum, corresponding to the most concave portion externally,—the umbo.

The length of the tendon of the tensor tympani muscle, from its beginning on the processus cochleariformis to its insertion, is from 2¾ to 3 mm.; further backwards, towards the mastoid process, the cavity of the tympanum becomes wider again, and measures about 6 mm.

The two ossicula auditus, incus, and stapes, proceed from walls lying opposite, and the head of the latter lies only 3 mm., and the end of the long process of the incus only 2 mm. from the posterior half of the membrana tympani. It should also be mentioned that the head of the malleus lies at a variable but always a short distance from the roof of the cavity; and that the broad surface of the incus lies very near the outer wall of the cavity of the

tympanum. There is also an extremely small distance between the sides of the stapes and the bony walls of the pelvis ovalis.

All these parts are covered by a mucous membrane which, like every other mucous membrane, is subject to inflammatory swelling, thickening and infiltration. At every attack of catarrh of the cavity of the tympanum the measurements that have just been given must become smaller to a certain extent. The space may be even entirely filled up when there is very great or repeated swelling of the membrane, so that some structures that have previously been separated come in contact with each other; and thus the space is rendered very much smaller. From this occasional contact of the swelled parts of the mucous membrane, adhesions may occur, especially when suppuration of the ear has taken place, or abnormal attachments or pseudo-membranes may be found.

Numerous variations may occur in different persons, in accordance with the measurements of different authors. In some skulls a very large cavity of the tympanum is found, in others a very small one. The greater number of the above measurements I obtained by making transverse sections, in which I sawed through the level of the pyramid, and came upon the membrana tympani as nearly vertically as was possible, preserving it and the outer wall. Such a section is seen in figure 15. But here, on account of greater distinctness, the section is continued through the membrana tympani and the auditory canal.

Mucous Membrane.—The lining of the cavity of the tympanum, as is well known, is a continuation of the mucous membrane of the Eustachian tube, and of the nasopharyngeal space. The mucous membrane is smooth, whitish, very thin and delicate. In adults, in some respects, it is more like a serous membrane. Its epithelium consists of pavement cells, which, according to *Kölliker's*[1]

[1] Würzburg Verhandlungen, 1855.

observations, made upon a person who had been hanged, exhibited a ciliary motion, except the inner surface of the membrana tympani and the ossicula. This is most decided on the floor of the cavity, where I also succeeded in finding them, and where the epithelial cells seemed a transition between flat and cylindrical cells. The existence of glands has as yet been denied. I have, however, found a racemose gland of quite a large size close to the membrana tympani, where the tube and cavity pass into one another. I have never found any glandular elements in the remaining portions of the cavity. The observations of *Luca*[1] render it probable, however, that glands may exist in abundance in this part.

The mucous membrane and periosteum cannot be separated in the cavity of the tympanum. The membrane, that we are accustomed to call mucous, is at the same time the carrier of the vessels for the bones. It takes the place, in other words, of a periosteum. This relation is one of importance, since every severe and long existing affection of the mucous membrane will react upon the nutrition of the bones forming the cavity of the tympanum. Every inflammation of the mucous membrane of the cavity is at the same time an inflammation of the periosteum. Every catarrh is a periostitis. If the inflammation has a chronic course, there is a greater tendency to thickening of the mucous membrane, and to hypertrophy of the bones,—to hyperostosis. In acute affections, as is well known, the mucous membrane is more inclined to ulcerate, and the periostitis more frequently leads to atrophy of the bones, inflammatory softening, and superficial caries.

Cavity of the Tympanum in the Fœtus.—In the fœtus the cavity of the tympanum, like the lungs, contains no air. All the anatomists since *Fabricius ab Aquapendente* assert

[1] Virchow's Archiv. XXIX, S. 7.

that it is filled with mucus. *Huschke*[1] states: "The cavity of the tympanum in the newly born, as well as in the fœtus, is still filled with mucus; and it is only after breathing and crying have been carried on for some time that the air passes through the Eustachian tube, and drives this mucus out." If "mucus," be considered as free tissue, as the product of a mucous membrane, this view is decidedly incorrect. There is no free mucus in the cavity of the tympanum of the fœtus and the newly born, but it is filled by a swelling of the mucous coat, especially of that covering the wall of the labyrinth, which extends like a thick cushion to the smooth inner surface of the membrana tympani, upon whose surface it lies closely. This cushion, which on section is muco-gelatinous in structure, has a vascular surface, and is covered by a beautiful nuclear polyonal and smooth epithelium. It consists of embryonal connective tissue (Virchow's mucous tissue), of a beautiful cellular net work in a mucous basis. This cushion of mucous membrane becomes smaller soon after birth, partly through shrinkage, partly by increased desquamation, and deliquescence proceeding from the surface, and thus room is made for the air.

According to several observations on children who died during parturition, or a little while before, the lessening in size of this cushion filling up the cavity of the tympanum was begun before birth. In such cases we find many epithelial cells in the cavity, filled with fat granules.

This existence of the mucous cushion in the cavity, which, so far as I know, I was the first to exhibit, may contribute to explain why affections of the middle ear are so very common in small children; a subject to which I shall devote more attention in a subsequent lecture.

[1] Sömmering's Anatomie, 1844, S. 897.

Ossicula Auditus.—It is well to notice, in regard to the ossicula, that they are developed at a very early period. They may be seen as early as the beginning of the third embryonal month. They are then cartilaginous, and the incus cannot be plainly distinguished from the stapes; but they are comparatively large at this period.

Their ossification begins before the end of the third month. In the fourth fœtal month, the lower portion of the malleus, from the neck on, consists of transparent cartilage, but the head has a thin bony shell. In the incus, the posterior and greater part of the articular surface, and the whole posterior (short) process is formed of reddish flexible cartilage. The stapes, at this time, is still completely cartilaginous, and only has an osseous point at its base and in each side. It is more than two-thirds as large as in an adult.

In the fœtus of the sixth or seventh month, the stapes is fully ossified; while on the incus a thin, soft layer of cartilage may be separated from the cartilaginous surface, and the lowest portion of the handle of the malleus is still cartilaginous. In a fœtus at the beginning of the ninth month, the ossicula are fully ossified; yet the dense, bony layer on the surface is very thin, and, within the reticular tissue, extremely delicate. The size is the same as in adults.

The compact osseous substance increases in density with age, so that in subsequent years the spongy tissue has completely disappeared.

LECTURE XII.

II. ANATOMY OF THE MIDDLE EAR.

THE MASTOID PROCESS.

The horizontal and the vertical portion.

THE EUSTACHIAN TUBE.

Formation and length; isthmus of the tube; tympanic orifice; pharyngeal orifice; construction of the cartilaginous portion; mucous membrane; caliber; the muscles of the tube and their function.

VESSELS AND NERVES OF MIDDLE EAR.

GENTLEMEN: Turning to the mastoid process, we find it to present the appearance of an appendage or appendix; a kind of air reservoir of the cavity of the tympanum. The bony cells of the mastoid process are not filled with marrow, but with air. The mastoid process may be divided into two parts. First, the horizontal part (*antrum mastoideum*[1]), which consists of one or more large cells, and is situated close behind and above the cavity of the tympanum, and therefore immediately below the *tegmen tympani*. It is developed in the child, and is always found as a large hollow cavity in the adult. In its normal condition it contains air; in pathological states, it is lined by greatly thickened mucous membrane, and often filled with fluid or inspissated pus, or with masses of epithelium containing

[1] Joseph considers the name "upper cavity of the tympanum" as more appropriate, since this space has no relation to the mastoid process.

cholestearine. The second part, the real process, is situated further down, and more superficially. In the adult it contains a complete system of bone cavities, of smaller and larger dimensions. This latter, or the vertical part, is the one which is usually or especially understood by the term "mastoid process." During childhood it is small and flat, and consists only of spongy bone tissue, and does not become fully developed till puberty; but even in adults its density varies very much, since at times the compact, and at other times the spongy tissue, predominates. Sometimes the cavities are very large, at another, they are only of small dimensions, provided with delicate or dense partitions. This process frequently becomes sclerosed or indurated, especially in old subjects, and is then converted into a dense bony mass, with scarcely any cavities. In other cases, of course in advanced age, all the air cells of the temporal bone are very largely developed.

The thickness of the compact cortical lamina differs as well towards the cavity of the cranium, as towards the surface of the body. Cases of remarkable attenuation of both sides, even actual holes, have been observed, which may become of practical importance. Thus the posterior wall towards the sigmoid groove of the transverse sinus, and the upper, towards the superior, petrosal sinus, are often so attenuated as to be transparent, or even perforated. These abnormities would become of great importance in inflammation of the middle ear, since the thin and bony, or even only membranous partition would readily permit the extension of the morbid process to the venous sinuses of the dura mater. The same rarefaction shows itself occasionally in the outer laminæ of the mastoid process, and explains the origin of many cases of sub-cutaneous emphysema which occur either spontaneously or after slight violence to the region of the ear, and spread over a large portion of the head. This emphysema is caused by air

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Eustachian Tube.—The Eustachian tube, which most anatomists suppose to be the remains of the first embryonal branchial fissure, establishes a communication between the pharynx and the cavity of the tympanum. It serves as an outlet for the secretion of the latter, but especially as a passage for the renewal of the air in the middle ear. It is therefore a ventilation tube, by means of which the meeting of strata of air of equal density before and behind the drum is made possible, and the air in the tympanum maintained of the same degree of tension as that of the external atmosphere.

In its structure it resembles the external auditory canal; for it is also divided into a bony and a cartilaginous portion. But the proportionate length of the different parts is here opposite to that which obtains in the auditory canal. In the latter the cartilaginous canal constitutes but a third of the whole. It amounts in the Eustachian tube to two-thirds, and is therefore much longer than the bony portion. The average length of the Eustachian tube is about 1½ inches, or, more accurately, 35 millimeters, of which 24 belong to the cartilaginous and 11 to the osseous portion. It must not be imagined, however, that the boundaries of these two portions are very sharply defined. The cartilaginous portion, especially, extends anteriorly and laterally farther towards the cavity of the tympanum than it does posteriorly and towards the middle; and thus the osseous canal commences sooner at this point, while the lower part of the tube projects laterally into the pharynx as a prominent swelling. The cartilaginous portion passes upward into the fibro-cartilaginous mass at the base of the brain, without very sharply defined margins; and the walls of the osseous portion are an immediate continuation of the walls of the cavity of the tympanum.

The Eustachian tube is narrowest where the cartilaginous portion is united to the bone. (Here it is 2 mm. high,

and 1 mm. wide.) This point may be called the isthmus of the tube. From this point it widens in both directions. At its widest point—the pharyngeal orifice—it measures 9 mm. in hight; in breadth, 5 mm. At the tympanic orifice, or opening into the cavity of the tympanum, the hight of the caliber is 5 mm.; the breadth 3 mm.

The aperture of the tube into the tympanum, the ostium tympanicum, or tympanic orifice, as is known, is not situated on the floor of the cavity, or in its lower portion,[1] where one would expect to find the opening of a tube of exit, but very near the roof of the cavity, and immediately opposite the entrance of the antrum mastoidum. The center of the pharyngeal orifice, which in the adult is shaped like the mouth of a trumpet, projects into the pharynx, has a gaping orifice, and usually lies on a level with the posterior extremity of the inferior inturbinated bone, and therefore a little higher than the floor of the nasal cavity. Many variations are, however, seen in the relations of these parts to each other. Occasionally the rounded end of the inferior inturbinated bone extends to the opening of the tube, so as to cover it. In cases of hyperæmia of this very vascular and highly erectile membrane, this may be of considerable influence on the condition of the tube.

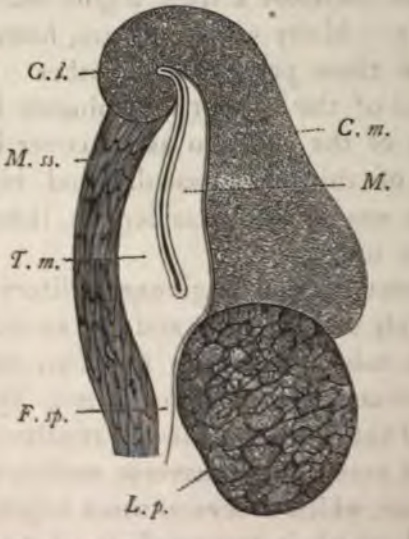
As we have seen, the cartilaginous auditory canal is not composed entirely of cartilage; and just so the cartilage of the Eustachian tube forms only a gutter, which is converted into a true tube by being closed by membrane. The cartilage of the tube consists of a median and a lateral plate, as is best seen in a transverse section of the same. The median plate, which is several times larger and broader than the lateral, which is but small, is of a very irregular and changeable form. On the whole, it resembles a nearly equilateral triangle with rounded angles, with its base

[1] In birds the Eustachian tube commences at the floor of the cavity of the tympanum.

pointing downwards, and towards the median line. lateral plate is inserted into the upper and outer part middle plate in the shape of a delicately bent hook *dinger*), below which the caliber and mucous membr the tube still extend for some distance upward.

The whole of the cartilage of the Eustachian tub middle plate of which is in immediate relation wit fibro-cartilaginous mass at the base of the skull, from it is, however, distinguished by a pretty sharply d curve of more homogeneous appearance, lies oblique that the hook-like cartilage, which is attached to the part, points outward and downwards. As the middl tilage plate is much larger than the lateral hoo cartilage, a pretty extensive space beneath the latter re free, which is filled up with a non-cartilaginous soft t

FIG. 16.



Transverse section of cartilaginous portion of Eustachian tube a the middle of its course (magnified five diameters): C. m., midd tilage. C. l., lateral cartilage (hook-cartilage). T. m., mem portion of tube, passing downwards into the salpingo-pharyngeal

(*F. sp*). *M.*, *mucous membrane lining the middle cartilage, and containing many glands.* *M. ss.*, *spheno-salpino-staphylinus muscle* (*abductor or dilator of the tube*). *L. p.*, *Levator palati muscle*; (*this muscle is frequently separated from the lower end of the fissure of the tube by much thinner intermediate tissue than it is in this case.*)

The so-called membranous portion of the tube commences at the upper part of the inner side of the hook cartilage. It is at first quite thin, but increases in thickness as it proceeds downwards to join the salpingo-pharyngeal fascia, which at this point of junction is pretty thick, but gradually becomes thinner. In adults, this membranous portion is the smaller half of the whole circumference of the tube, since it makes up, apart from the cartilaginous hook portion, the entire lateral wall, and usually, also, the lower wall, or the floor of the cartilaginous tube.

The mucous membrane of the tube, as is well known, is an immediate continuation of the naso-pharyngeal mucous membrane. At the pharyngeal orifice it is very thick, puffy, folded, and contains a great number of grape-shaped mucous glands, whose openings may be generally distinguished with the naked eye. From the pharyngeal orifice upward, the mucous membrane loses more and more of its density; but it is always thicker on the inner side of the median cartilage than on the inner surface of the membranous wall. On the tympanic orifice it is again thicker and more vascular, and also contains a few quite large grape-shaped glands. *Ludw. Mayer* found vascular net-work on the floor of the bony tube, consisting chiefly of large vessels anastomosing with each other. According to *Rüdinger*,[1] the mucous glands of the tube, as well as those of the upper portion of the pharynx, are traversed by numerous

[1] *Rudinger* (Ein Beitrag zur Anatomie und Histologie der Tuba Eustachii), and *Henle*, (Handbuch, II, 3, S. 755), assert that the whole of this part of the wall of the tube consists chiefly of fat. I have only found much of it in the lowermost portion..

nerves in a net-work; and these nerve twigs are intersected by ganglia. The epithelium of the tube is ciliated, and the movement is towards the pharynx from the cavity of the tympanum. On the cadaver we often find, throughout the whole length of the tube, abundant mucous secretions, always mixed with cylinder epithelium, which has been thrown off, whose cilia may be seen as a rule sometime after death.

The Eustachian tube of the child differs in many respects from that of the adult. In the first place, it is to be observed that the two portions differ less in their length, and that consequently the osseous portion is here comparatively longer than in the adult. Taken as a whole, it is much shorter, and at the same time is not only relatively but absolutely wider at its narrowest point. Its opening into the cavity of the tympanum is also much wider than it is in the adult; and we might therefore conceive that a discharge of purulent secretion might frequently take place during childhood. On the other hand, this tube is placed nearly horizontal in children, while in adults it is inclined from above downwards. The mucous membrane frequently exhibits folds which are placed at tolerably regular intervals. The cartilage has not yet the form which it subsequently assumes; the pharyngeal orifice does not protrude so much into the pharynx, and the narrow lips of the chink-like opening usually lie in such close contact with each other, that it is frequently very difficult to find it in the swelled mucous membrane of the pharynx in post mortem examinations of children. This is also the reason that in catheterization of the child, the posterior lip of the cartilage is much more rarely felt than in the adult, in whom it projects in the form of a pad (Wulst) into the pharynx; for the same reason, closure of the tube near its pha- al orifice can be the more readily developed in the during an inflammatory swelling of the pharyngeal

mucous membrane. A very beautiful view, strikingly contrasting with the surrounding substance, is presented here by a transverse section of the cartilage of the tube. Since the middle plate expands less from above downwards, the two plates resemble a staff with its upper end bent in the shape of a crosier. Whilst the membranous wall in the adult forms the smaller half of the entire circumference of the tube, it occupies by far the greater half in the infant. This is due to the more developed condition of the lower wall or floor of the Eustachian tube. In consequence of the smallness of the hook cartilage, the soft or membranous portion occupies nearly both sides of the irregular triangle. This condition at the same time explains the expansibility or width of the tube in the child, while its great narrowness at the pharyngeal orifice is due to the yet very slight development in the breadth of the middle cartilaginous plate.

The question of the caliber (lumen) of the cartilaginous portion of the tube is of great importance; that is whether its walls usually gape, and are separated from each other, or whether, in repose, they lie in contact with each other, special force being required to separate them. Without referring to the osseous tube, which, so long as its lining membrane is in a physiological condition, contains air the same as the cavity of the tympanum, the walls of the pharyngeal extremity of the tube are separated from each other like a funnel; and there exists, furthermore, at the point of junction of the osseous and cartilaginous portions for a short distance beneath the hook cartilage, a small space filled with air. In the remaining, that is, the greater part of the cartilaginous portion, I have never been able to find anything of a free space, that is commonly open. On the contrary, the mucous surfaces of the middle and the lateral wall lie here against each other throughout their entire length, so that only a somewhat long, often slightly S shaped, curved fissure exists between them.

According to *Rüdinger's* description and plate there exists, below the hook cartilage in the uppermost part of the fissure of the tube, a free and rounded space, constantly filled with air, which is formed and bounded below by two valvular projections of the mucous membrane, opposite to each other, and which are always present, and cannot be smoothed down. Although I have made many sections of previously hardened preparations, I have never been able to convince myself of the presence of such a free space, without regard to the uppermost part of the cartilaginous tube; nor have I ever been able to see positively the membranous valves described by Rüdinger. *Lucæ*[1] also could not convince himself of the latter; while, according to him, there is a free space under the cartilaginous hook. My researches in comparative anatomy, which I made for this purpose in various mammiferous animals, moreover speak decidedly against the presence of a constantly open space in the tube; for, notwithstanding the great variety prevailing in the arrangement and shape of the cartilaginous and membranous portions of the tube in different animals, the walls were always found to be constructed in such a way as to necessitate their lying against each other through their entire length. Sections of the Eustachian tube of carnivora are most instructive on this point. Very recently *Rüdinger*[2] has published some observations on the comparative anatomy of the tube, which verify this idea as to the existence of a free space in its uppermost part.

This fissure, in the lowest part, 8–9 millimetres high, decreases in length in the upper part, and can, near the isthmus of the tube, be dilated to 1½–2 millimetres at the most. (This is the rule; there are, however, some remarkably wide tubes.) That the walls ordinarily lie but lightly against each other, is made apparent by a consideration of the physiological importance of the tube as a duct lined with ciliated epithelium for the discharge of the secretions of the cavity of the tympanum. This is furthermore proved by the fact, that a very slight pressure of air, such as, for example, results from eructation, often suffices to

[1] Zur Function der Tuba Eustachii, Archiv. für Ohrenheilkunde, III, S. 174, Beiträge zur Anatomie der Ohrtrompete, L. C., B. II, S. 217.

[2] Monatschrift für Ohrenheilkunde, No. 1, Oct., 1867.

separate the walls from each other, so that we feel the air entering into the ears. It is also well known that in cases of perforation of the drum, the fluid injected without any force into the external meatus frequently escapes through the Eustachian tube into the pharynx.

But if this tube is at the same time to be a ventilation tube, by means of which a regular exchange of air between the pharynx and the cavity of the tympanum is brought about, it is necessary that its regular and frequent gaping or opening should take place only in this wise, that the strata of air, before and behind the membrana tympani, be kept of the same tension and density that is requisite for a normal vibratory capacity for the drum! Experience has shown that such an opening of the tube takes place with every act of deglutition. You may experience this upon yourselves, if you at first swallow a few times with mouth and nose closed, and afterwards swallow with these cavities open. While you at first dilute the air in the cavity of the tympanum, the membrana tympani moves inwards, and you perceive, beside some noises, a feeling of pressure and fullness in the ear, which gives way to the normal sensation as soon as, by swallowing with the nose open, we permit the air of the cavity of the tympanum to equalize itself with that of the pharynx. You may also readily convince yourselves of the influence exerted by the act of deglutition upon the Eustachian tube, by examining a patient. In auscultating the ear whilst air is being injected through the catheter, you will hear the entering of the air much more distinctly at the moment when the patient swallows; and the patient himself will also, at the same time, feel the air much more forcibly in his ear. Other proofs of the opening of the tube during deglutition we shall learn hereafter.

How, now, are the motor forces arranged which bring about this temporary gaping of the tube? The majority

of anatomical authorities either pay no attention at all to the relations of the upper muscles of deglutition—the tensor, and the levator palati—of the Eustachian tube, or else allude to them only incidentally. But amongst the few that have recognized these muscles as muscles of the tube, and also have subjected their action to a close scrutiny, very different views prevail as regards the details. In view of the great importance of this subject, I consider it a duty to treat of it as fully as possible, just as it has been revealed to me by my anatomical investigations.

Muscles of the Tube.—The spheno-salpingo-staphylinus, or circumflexus palati, or tensor palati mollis muscle, arises not only from the sphenoid bone, but a large portion of its fibers take their origin from the outer and under surface of the lateral hook cartilage, as well as from the contiguous portion of the membranous wall of the Eustachian tube. A little further downwards the posterior surface of the thin and flat belly of this muscle lies in so close and intimate contact with the membranous tube, and is, by means of short and tense connective tissue, so closely interwoven with it, that it is very difficult to separate the tube from this muscle. Towards the pharyngeal orifice the fibers of the muscle can be more easily separated from it, while in its upper part, towards the osseous portion of the tube, the union with the membranous portion becomes more and more intimate, and the number of fibers evidently arising here, constantly increases. Furthermore, there exists, also, a very close relation between this muscle and the fascia, with which, as we have already mentioned, the lowest portion of the membranous wall, at its outer part, becomes united. As this fascia arises from the entire length of the membranous tube, and passes backwards and downwards to the latero-posterior wall of the pharynx, it may with propriety be denominated the salpingo-pharyngeal fascia.

Whilst the said fascia passes beneath the under surface of the tensor palati muscle the fibers of the same do not only lie in very close contact with it, but a few of them also take their origin here, which is especially noticeable at its upper part, where this layer of connective tissue, having constantly increased in thickness, is inserted into the petrous portion of the temporal bone.

The muscle itself passes downwards and outwards at an acute angle to the axis of the tube and its tendon, and as you are aware, winds round the hamular process. As soon, now, as its lower extremity reaches a point of fixation, contraction of its fibers must result in the drawing downwards and outwards of its upper points of insertion, so far sa they are movable. These are, first, the lateral cartilage,[1] the hook cartilage. Secondly, the membranous wall of the tube; the latter must be drawn particularly in the before mentioned directions at its lower expanded termination, by the salpingo-pharyngeal fascia. Contraction of the spheno-salpingo-staphylinus muscle consequently ought to draw the entire lateral, partly cartilaginous, and partly membranous wall of the tube away from the middle wall, and thus produce gaping of the canal of the tube. According to experience, the latter takes place with every act of swallowing; and we must therefore assume that, with this act, all the conditions have been supplied to allow the drawing-down action of the muscle just described to become effective; that is to say, the conditions which afford to those of its fibers which arise from the lateral wall, a fixed point below, and at the same time stretch the salpingo-pharyngeal fascia in a downward direction.

This process may be illustrated on the cadaver, by pulling on the belly of the muscle. At the same time, especially if the movement

[1] *Rüdinger* first stated that this cartilage is movable. This anatomist has, by teaching the study of the conformation of the tube from sections, rendered very essential service in the investigation of this subject.

be made rapidly, and the mucous surface be well moistened, that peculiar cracking noise is heard, which was formerly supposed to be located in the middle ear, and was thought to be the result of the contraction of tensor tympani, until *Politzer*[1] experimentally proved its true cause.

Such proof very readily results from a consideration of the process of deglutition. During the act of swallowing the soft palate is, by means of the lower muscles of the palate, the glosso-palatini, and especially by the more powerful pharyngo-palatini muscles, stretched in a downward and backward direction, and pressed against the posterior wall of the pharynx, so that it obtains a fixed position. But, as with the act of deglutition, a contraction takes place simultaneously in the antagonists of the muscles under consideration, the upper muscles of the pharynx (the tensor and the levator palati) will change points of fixation and attachment in such a way that the soft palate becomes the (relatively) fixed point, and the lateral, movable wall of the tube, on the other hand, the point of origin of the muscular fibers from which motion proceeds.[2]

So far we have not even mentioned the other points of support of the tensor palati muscle. First, its tendon is so firmly and strongly fastened to the hamular process that without previous loosening of this attachment, even powerful traction on the belly of the muscle fails to produce the slightest motion in the soft palati. From this, it would seem as if we had here a very essential point of fixation for the operation of this muscle, which has not yet been at all sufficiently valued. We must here, also, take into consideration that part of the upper constrictor of the pharynx which, on account of its passing sidewards and forwards to the pterygoid process of the sphenoid

[1] Wiener Medicinalhalle, 1862, No. 18.
[2] Politzer, Wiener Medic. Wochenschrift, 1863, No. 6.

bone, has been called the pterygo-pharyngeus muscle. This muscle is inserted into the anterior and lower side of the hamular process, in such a way that it must be looked upon as an antagonist of the circumflexus muscle and its tendon, which is situated at the posterior and lower portion of the hamular process.

This antagonistic relation of pterygo-pharyngeus to the circumflexus is especially marked in the horse; for here the tendon of the former, like that of a pully-muscle, is perfectly movable where it winds round the hamular process. In the horse, both of these muscles might justly be considered as one muscle with two bellies—a tubal and a pharyngeal belly—which lie in a rounded acute angle to each other; the angle being formed, i. e., fitted, by the pully of the hamular process. (See Archiv. für Ohrenheilkunde, II, p. 218.)

During contraction of this constrictor, the point of attachment of the circumflexus muscle to the hamular process must become the more fixed, and the development of its action in the direction towards the tube made the more easy. The salpingo-pharyngeal fascia is also inserted into this muscle, and it, as well as the lower portion of the membranous wall, can therefore be put upon the stretch by this muscle.

Hence, there can be no doubt that during the act of deglutition the sphengo-salpino-staphylinus muscle finds a fixed point below; that it draws the movable part of the tube outward and downward, and opens the tube. *Politzer* has, moreover, proved this influence of the muscle in question upon the tube, by experiments made in the Physiological Institute of this city.[1] As this muscle, on its other side, is surely not a "tensor of the soft palate," but only a "tensor of the fibrous prolongation of the hard palate" (*Henle*), the name tensor palati should certainly be

[1] Ueber Eine Beziehung der Trigeminus zur Eustachian Ohrtrompete, Würzburger Naturwissenschaftliche Zeitschrift, 1861, p. 94.

abandoned, and it, on account of its great importance for the tube, be termed the *abductor* or *dilator* of the tube; for it must be regarded as an abductor of the lateral wall, and therefore as a dilator of the tube, and as an integrant part of the ear.

Henle, in the first part of the second volume of his "Anatomisches Handbuch," absolutely denies that fibers of the circumflexus palati take their origin from the membranous tube, and consequently had to question all dilating influence of this muscle upon the tube. He even regarded it more probable that its fibers, during the moment of contraction, press the wall of the tube towards the median line, and thus close the tube more firmly. In the third part of the same volume (1866, p. 755), he admits that it is this muscle which opens the tube with every act of swallowing; but he still holds that only a few fibers of this muscle take their origin from the movable portion of the Eustachian tube. For he says: "A portion of the tendinous fibers (sehnige ursprünge) of the spheno-staphylinus muscle fuse with the firmer part of the lateral wall; and in truth, these tendinous fibers press themselves through a thin layer, between the upper margin of the soft wall of the tube and the curved portion of the tubal cartilage, to become fused with the convex surface of the latter. By this adhesion to the cartilage of the tube, the spheno-staphylus muscle is enabled to unroll the upper rolled-up margin of the cartilage, and to enlarge the angle which the lateral forms with the median wall." *Rüdinger* pronounces "the blunt extremity of the hook cartilage, which is pointed downwards and inwards, to be the essential point of insertion of this muscle." He furthermore recognizes a connection between the tendon of the muscle and the membranous wall of the tube (which he usually denotes "layer of fat," or "group of glands"). This, however, is not brought about by the attachment of tendinous fibers, but by bundles of connective tissue, the arrangement of which is such that they can be distinguished from the tendon. "During the contraction of this muscle, the hook-shaped portion of the cartilage is drawn downwards and somewhat sidewards; and the movement of the hook-shaped cartilage must follow the membranous wall of the tube which is connected with it."

It is interesting to notice that the muscle under consideration was, by its discoverer, *Valsalva* (1707), described under the name, "Novus

Tubæ Eustachianæ Musculus;" and he understood that it was a dilator of the tube, while more recent anatomists have considered it solely or mainly with respect to its importance to the palate.

The second of the muscles to be considered here, the *petro-salpingo-staphylinus*, or *levator palati mollis*, arises mainly from the under surface of the petrous portion of the temporal bone, very near the entrance of the carotid canal. This muscle lies in very close contact with the movable part of the cartilaginous portion of the tube; but none of its fibers arise from any part of the same, although this is asserted by many authors. The roundish and cylindrical levator proceeds parallel with the tube, immediately under its floor or lower wall, and also slightly towards the middle. This wall consists usually of a very thin membranous tissue. Indeed, not unfrequently this muscle lies immediately beneath the mucous membrane, at the lower end of the opening of the tube. The salpingo-pharyngeal fascia passes between this and the previously described abductorof the tube; the latter lies more outward (laterally) and upward; the levator, on the other hand, more toward the middle and downward.

This functional importance of this muscle, probably, chiefly concerns the palate, which, by the united action of both muscles, is lifted directly upward. With this, a narrowing of the pharyngeal orifice of the tube takes place; the floor of the tube being pressed upward and outward by the muscle, as it increases in thickness during its contraction. This constriction of the pharyngeal orifice may be observed by means of the rhinoscope. At the same time the entire configuration of the pharyngeal orifice undergoes an essential alteration; its lower curved margin becoming more rectilinear or even arched in an upward and outward direction; since the mouth of the tube, which was previously widely open and sloping downward, no longer falls off steeply toward the cavity of the mouth

and pharynx, it will, by the elevation of the velum palati, be doubly protected against all mechanical influences coming from below, especially against articles of food and other foreign bodies which, during vomiting or sneezing, occasionally find their way into the upper part of the pharynx. It cannot be stated with precision in how far contraction of this muscle exerts a positive influence upon the caliber of the canal in the remaining portion of the tube; but as the fascia which borders it might be stretched outward, and the floor of the tube be crowded upward by its swelling, it might, by drawing the membranous wall of the tube sideward, be enabled to assist in producing gaping of at least the lower part of the tubal opening.

According to *A. Lucæ* and *Schwartze* (Archiv. für Ohrenheilkunde, I, S. 96, u. S. 139), simple respiratory movements will, in many cases of a normally pervious Eustachian tube, be sufficient to produce a manometrically provable change of air in the cavity of the tympanum, and this usually produces visible movements in the membrana tympani. *Lucæ's* sterling and thorough observations, which were made on patients, and also on numerous individuals with normal ears, proved that there existed a constant relation between these processes in the cavity of the tympanum on the one hand, and the movements of the soft palate, and the faucial orifice of the tube during inspiration, on the other. With the inspiration there showed itself,

relation with the respiratory system. *Politzer*[1] is of opinion that, ordinarily, during respiration, the tube does not become open, and that no movement takes place in the normal drum. Considering the importance of this question, further thorough examinations, especially on individuals with sound ears, are exceedingly desirable. *Lucæ* indicates its great practical importance by saying: "It is not improbable that all diseases, which in any way disturb the respiratory function, also indirectly more or less impede the respiratory act of the ear, and thereby, perhaps, aid in the production of certain diseases of the organ."

In his most recent publication on this subject, *Lucæ* maintains his view as to the permeability of the tube in simple respiration, and supports it by numerous new examinations on persons with normal hearing power. He also shows, in the oblique position of the tube, and the position of the membranous wall below, and externally, that the latter must necessarily, by the weight of the muscle arising from it, and the soft palate, be drawn away.

I may also mention a fact, which is as yet unexplainable to me. In cases where, during the existence of catarrh of the pharynx, all attempts at Valsalva's experiment, even when very forcibly and frequently made, are attended with failure, and in which we must therefore assume that the walls of the tube are firmly pasted together by very tenacious mucus, simple ructus—air belched from the stomach—will at the same time often enter the ear with unusual force.

Vessels and Nerves of the Middle Ear.—The cavity of the tympanum receives its supply of nutriment from very different sources. One of these is the stylo-mastoid branch of the posterior auricular artery (external carotid), which, in its course through the Fallopian canal, also gives off branches to the coverings of the facial nerve, to the stapedius muscle, and at the same time supplies the cells of the mastoid process. The ascending pharyngeal artery (from the external carotid) supplies the lining membrane of the cavity of the tympanum, the mucous membrane of the Eustachian tube, and the tensor tympani muscle. The

[1] Beluchtungstilder des Trommelfells, S. 139. This work has been translated by Drs. Matthewson and Newton of Brooklyn, and will soon be published.—St. J. R.

middle meningeal artery (maxillary internal) which, as is well known, supplies the greater part of the dura mater, sends branches to the cavity of the tympanum as well as to the Eustachian tube; they enter through the *hiatus canalis Fallopii* and the petro-squamosal fissure. Lastly, one or two branches are given off from the internal carotid, as it passes through the petrous bone, which enter from the carotid canal, and are distributed to the cavity of the tympanum and the Eustachian tube.

The nerves of the middle ear are derived from the trigeminus, the facial, the glosso-pharyngeal, the vagus, and from the great sympathetic. The otic ganglion and the chorda tympani also supply this cavity.

The tensor tympani receives a small branch from the motor internal pterygoid nerve, which is itself a branch of the third division of the trifacial. It also receives a filament from the otic ganglion. According to *Luschka*,[1] the former presides over the voluntary, and the latter the involuntary tension of the membrana tympani. It is said that the voluntary activity of the tensor tympani is always accompanied by movements of the soft palate, which also receive branches from the internal pterygoid; and *Luschka* is of opinion that the opening of the mouth in listening is associated with a simultaneous tension of the velum palati, and that it by no means proceeds from a widening

The nerves of the mucous membrane of the cavity of the tympanum, and Eustachian tube are derived from the glosso-pharyngeal, whose tympanic branch (or Jacobson's nerve) penetrates the floor, and ascends the promontory.[1] Finally, the vagus sends a branch to the levator palati mollis, which we must regard as a muscle of the tube, and which therefore belongs to the ear.

All authors state that the great sympathetic furnishes branches to the cavity of the tympanum, but they differ as to the manner in which this is done. *Hyrtl* describes a tympanic plexus, which little net consists of a combination of the great sympathetic, the trifacial, and the glosso-pharyngeal. It is situated on the floor and the anterior part of the wall of the labyrinth, and supplies the lining membrane of the entire middle ear — the cavity of the tympanum, the mastoid cells, and the Eustachian tube. According to *W. Krause*, the highly nervous mucous membrane of the Eustachian tube does not only receive microscopic branches from this tympanic plexus, but a larger branch may be traced to the cartilaginous tube.

It may be mentioned here that *F. Arnold*[2] has described two recurrent branches of the trifacial, which pass along the bony surface of the middle cerebral fossa, and a recurrent branch of the pneumo-gastric, which proceed to the transverse sinus and to the posterior cerebral fossa.[2]

In reference to the origin of the nerves composing the tympanic plexus, we have to distinguish:

1. Several nervi carotico-tympanci, branches from the plexus of the sympathetic in the carotid canal, which enter the cavity of the tympanum through special foramina.

2. A twig of the superficial petrosal nerve, entering the cavity from above, being a connection between the otic

[1] According to *W. Krause* (Zeitschrift für ration. Medizin, 1866, B. XXIII, S. 92), ganglion cells are imbedded in various parts of the tympanic nerve.

[2] Zeitschrift der Ges. der Weiner Aerzte, 1861.

ganglion and the bend of the facial, but which, according to other authors, is to be regarded a continuation of the tympanic (Jacobson's nerve) to the otic ganglion.

3. The ramifications of the tympanic from the glosso-pharyngeal.

The otic ganglion, or Arnold's ganglion, is certainly of the same importance to the organ of hearing as the ciliary ganglion is to the eye; but physiology has, as yet, paid but little attention to it. It is situated near the foramen ovale of the greater wing of the sphenoid bone, in front of the middle meningeal artery, on the outer side of the cartilaginous portion of the Eustachian tube and the point of origin of the tensor tympani. It is composed of motor fibers from the third division of the fifth nerve, of sensitive fibers from the glosso-pharyngeal, and of fibers from the great sympathetic. The otic ganglion sends the before mentioned little branch to the tensor tympani, which governs its reflex activity. It sends a twig to the external pterygoid branch of the trigeminus, and several branches of communication to the nerve auriculari of the third division of the fifth, which, as we have seen, supplies the integument of the external auditory canal and the membrana tympani. By means of this ganglion, the soft palate, the drum with its tensor muscle, the lining membrane of the cavity of the tympanum, and the integument of the external ear, are put in sympathetic relation with each other, and with the nervous system generally.

The chorda tympani of the facial, though it passes along the outer wall of the cavity of the tympanum, does not, according to the statements of most reliable investigators, [illegible] branch to this cavity, and [illegible] appears, therefore, to be [illegible]ysiological relation with [illegible] it.

LECTURE XIII.

CATHETERIZATION OF THE EUSTACHIAN TUBE.

The history of the subject; common errors in the use of the catheter; method of introduction; accidents which may occur; spasm of the œsophagus; emphysema; hemorrhage; description of the catheter.

GENTLEMEN: Now that we have studied the anatomy of the middle ear, we may turn our attention to the diseases which may arise in this part of the organ of hearing. In order to act directly upon the cavity of the tympanum, in its deeply situated position, we must make an approach from without; in other words, we must elongate the external opening of the Eustachian tube. Otherwise, we shall not be able to perfectly recognize the abnormal conditions of this part of the ear; and still less can we treat its affections directly and locally.

For the purpose of reaching the middle part of the ear, we introduce a tube into the pharyngeal orifice of the Eustachian canal. This instrument is called an ear, or Eustachian catheter. It now becomes our task to examine into the method of employing this instrument. We shall also study its practical value, and investigate the appliances and instruments which may assist us in its useful employment.

It was an extremely long time before physicians recognized the fact, that there was any sort of practical and therapeutical use to be made of the passage connecting the ear and the throat. The existence of the Eustachian tube

was certainly known to *Aristotle*. It was first examined and exactly described by *Bartholomeus Eustachius* in 1562.[1] But more than a hundred and fifty years passed before a layman made the first attempt to introduce an instrument into the Eustachian tube. As is well known, *Guyot*, the post-master of Versailles, in 1724, proposed to the Paris Academy to inject the Eustachian tube through a curved tin tube, introduced through the mouth. He is said to have in this manner relieved himself of deafness, which had existed for a long time. A surgeon in the English army, *Archibald Cleland*, in 1741, without seeming to know anything of *Guyot's* method, proposed to introduce a tube through the nostril. This method is the only one that is practicable, and still employed.

Any one who wishes to be able to diagnosticate and treat diseases of the ear, must be able to use the Eustachian catheter. We are constantly required to use it in practice, and in many cases it can be by no means fully replaced. You will find a general conviction among surgeons, that the introduction of the Eustachian catheter is a very difficult, as well as a painful operation. You, however, have seen that such is not generally the case; and that it is only true in exceptional and rare instances. On the contrary, this operation, in by far the greater number of cases, is an easy and painless one, if we but understand the anatomy

all the little difficulties in the way of an easy introduction of the catheter.

I use a silver catheter, bulbous-shaped at its curved end, with a ring on the side of its funnel-shaped extremity. This ring shows us, by its position, the exact situation of the point of the instrument. We should always, during the introduction of the instrument, keep a finger upon the ring, in order that the direction of the beak may be clear to us, and in order that we may readily turn it. Oiling the instrument before introduction seems to me unnecessary. It is well to cause the patient to blow his nose before the operation, in order that slight temporary obstructions may be removed, and the canal somewhat moistened. I will now go over all the steps of the operation, as I have already done on a half head of a cadaver, and upon some of you yourselves. We introduce the bulbous-shaped, curved extremity of the catheter, with the point directed a little downward, into the inferior meatus of the nose, then quickly raise the whole instrument, so that the ring shall be exactly on a vertical line, and push it carefully further in, hugging the floor of the nasal cavity, till the posterior wall of the pharynx be reached, where we touch the atlas and basilar portion of the occipital bone. Then the catheter is drawn from one-third to three-fourths inch backward, toward the operator; the outer end is somewhat elevated, and the ring, which has hitherto been on a vertical line, is turned to one running upward, and outward or

Fig. 17.

Eustachian Cathet

opposite to the external ear. In some rare cases, the ring can only be made to lie horizontally. This is more apt to be the case in children than in adults. It is well to support the head of the patient during the operation by a hand passed around the back of the head. Both surgeon and patient may stand, or both sit, while the catheter is being introduced. (I find it much more convenient for the patient to sit, while the surgeon stands, in the performance of the operation. St. J. R.)

The above described method is the one given by *Kramer*, and is undoubtedly the best. It has been advised not to pass the instrument as far back as the wall of the pharynx, but to first attempt to turn the point of the instrument into the mouth of the canal, which is situated somewhat anterior. This method seems quicker and more convenient, because we are not obliged to pass over the same way twice. But it is, after all, a much less certain method, because the surgeon is not generally able to tell at what instant the instrument leaves the inferior nasal meatus, and enters the naso-pharyngeal space. It is much easier to know just where the instrument is, if we proceed as above described; that is, if we first introduce it to the posterior wall of the pharynx, and then withdraw it a portion of the way.

Let us now examine the various steps of the manipulation a little more exactly, and at the same time mention the most frequent errors, as well as some difficulties that may occur.

In the first place, in the introduction of the catheter, we should avoid delaying on the nasal meatus, or pushing the instrument about in that locality, for the part is very sensitive and ticklish. In many cases it is well to draw the upper lip down, with a finger of the other hand, and thus render the nasal meatus more permeable. In some narrow, fissure-like nasal passages, the introduction

will be made easier by drawing the ala of the nose to one side. The beginner should place his patient opposite a window, in order to illuminate the parts well.

As soon as the instrument has entered the meatus, the catheter should be changed from its oblique or vertical position to one that is horizontal, and then be kept quickly but firmly in this latter one, hugging the floor of the meatus till the posterior wall of the pharynx is reached. If we do not observe this precaution, there is danger of passing the instrument into the middle meatus of the nose, the passage of which is painful, and from which it is often impossible to turn the beak into the mouth of the tube. The lower nasal meatus and the floor of the passage are much less sensitive than the middle passage. The latter alone is adapted for the passage of the catheter.

It is only in rare cases that there is any danger after the instrument has entered the inferior meatus, of passing from it into the middle one. When the inferior turbinated bone is small, and the lower meatus very narrow, this accident may sometimes occur, but it is always to be avoided by following the rule given above; that is, to hug the floor of the meatus with the beak of the instrument. If the catheter has been introduced through the inferior meatus, it always stands nearly at a right angle to the surface of the face. If it has entered the middle one—a not unfrequent error—it will be in an oblique position, and will form an acute angle to the facial plane.

As a rule, the beak of the catheter should be directed downward in passing through the nostril. If we find any difficulties in introducing the instrument in this manner, we should try to avoid them by lateral movements of the catheter. Such lateral movements should at first always be made with the beak outward, and at the same time the extremity of the instrument should be held with a delicate but firmer hand in the tips of the fingers.

I have not unfrequently met with cases, where, in order to obviate the difficulties from irregularities in the nasal canal, I have been obliged to turn the catheter completely on its axis, as we are often compelled to do in catheterization of the urethra. The manipulation is there known, as *le tour du maître.* If we do not succeed in entering the mouth of the tube by these manipulations, we should take another catheter, one that has a different curvature, or that is of a smaller caliber. I have found these difficulties in catheterization somewhat more frequently on the left side than on the right; hence, I would advise that you always begin with the right nostril, in examining patients. On examining a number of macerated skulls, I find that the bony wall, which seldom stands exactly on the median line, is oftener deviated to the left than the right. Sometimes the whole of the former stands in an oblique position, while again only a portion of its surface is bulged out. There is also a great variety in the conformation and development of the inferior turbinated bone. Added to these deviations from a strictly normal condition, the outer part of the nose, in most persons, is placed a little obliquely toward the left. The most common mistake in the introduction of the instrument is, that it is not withdrawn far enough after it has reached the posterior wall of the pharynx. The beak thus falls into the little fossa, called Rosenmüller's fossa, situated behind the mouth of the Eustachian tube. We may make this mistake by half unconsciously pushing the instrument backward in turning it. This mistake is the less remarked, because in gently withdrawing the catheter from this position, there is about the same sensation of resistance as when it is in the mouth of the tube itself. If we blow through the catheter when it is in this position the air is felt, not in the ear, but in the neck, and we have a moist, fluttering sound, as if mucus collected there had been set in motion. *Benjamin Bell*, the distinguished Edinburgh surgeon, says

that when aurists claim to have entered the entrance of the Eustachian canal, they have only entered this fossa. This statement, of course, proves nothing more that that great men sometimes make great mistakes. It is true that this error of lodging the instrument in this fossa is a mistake often made, and not always by beginners alone, but by those who have had great experience with the catheter. This may be explained by the fact, that there is no rule, as to just how far we shall withdraw the point of the instrument, after having reached the posterior wall of the pharynx, since the distance of the mouth of the tube from the vertebræ is different in different individuals.

Tortual, in his "Untersuchungen über den Bau der Menschlichen Schlund and Kehlkopfes," Leipzig, 1846, states—basing his opinion on a great number of measurements of the skulls of men and animals—that there is always a certain proportion, in fully grown persons, between the depth of the head of the pharynx (Schlund Kopf) and the hight of the semi-circular lateral surface of the skull, that is, the point of origin and development of the temporal muscles. It is conceivable that, from this proposition, conclusions could be formed, by an examination on the living subject, of the distance of the mouth of the tube from the posterior wall of the pharynx. Man is distinguished from the other mammalia by having the least depth of pharynx and the slightest development of the temporal muscles. Men of an animal organization, with very large masticating and deglutory muscles, have also a great depth of the pharynx.

Beginners are more apt to turn the beak too late than too early. After some practice, however, we become certain in the use of the instrument. The introduction of the instrument into the mouth of the canal, in the case of children, is difficult, especially if the mucous membrane is swollen and puffy. The pharyngeal orifice of the tube in children is not so far forward in the pharynx as in adults; and the small undeveloped lips of the opening lie so far apart that we often have trouble, even on the cadaver of an infant, in placing the instrument in the proper opening.

Occasionally, although rarely, after we have had some practice with the instrument, a case occurs where one side of the nose is impassable. This may occur in consequence of abnormal narrowing of the inferior meatus, as well as from nasal polypi and granulations, or swellings on the inferior turbinated bone, from which bleeding readily occurs, and also in consequence of a particularly oblique position of the nasal septum.

Thus, I have several times found the cartilaginous septum bulged out to one side, to such an extent that the meatus could scarcely be entered with a probe. I once found the inferior nasal meatus of one side nearly impermeable in consequence of an abscess of the gum. This was a case where a catheter had been regularly introduced for several weeks without any difficulty or pain. In some cases impermeability of the meatus may be due to former injury of the nose, to which, in the period of childhood, we are especially exposed. (As an instance of the frequency of the cases in which an impermeability of one nasal meatus exists, I may state, in confirmation of the author's views, that while writing the very lines above, I was called on by a patient in whom the left nasal passage was impervious to even the smallest catheter, in consequence of an injury done to the nose from a ball thrown by a play-fellow. St. J. R.)

Any abnormities which are more deeply situated than the above, may be brought to view by placing a larger aural speculum, or Kramer's dilating speculum, in the nose, at the same time illuminating the parts with the mirror. In other cases, an examination of the naso-pharyngeal space with the rhinoscope will determine the nature of the obstruction.

In the comparatively rare cases where one nasal meatus is impermeable, we may generally introduce the catheter

from the other meatus, an operation that has been improperly pronounced by some to be impossible. I do not use any especial instrument for this, except a catheter with a long beak, and of greater curvature than is otherwise necessary. Of course, we cannot as readily and certainly find the mouth of the tube from the opposite side. The catheter is easily displaced, the current of air is not so powerful, and a rattling sound is heard in the throat; but in case of necessity we may adopt this method. Of course, practice with the instrument makes the cases, where it cannot be introduce without difficulty, always rarer. As a last resort, in cases of failure to pass through the nostril, we may attempt to introduce the catheter through the mouth, as *Guyot* proposed. During rhinoscopy, it would not be difficult to introduce a properly curved instrument, e. g., a caustic holder, into the mouth of the tube, through the mouth; and the introduction of a catheter of similar curvature would not be difficult.[1]

Once more then, gentlemen, catheterization of the ear is by no means difficult. Every physician will soon accomplish it with ease, if he will but take the trouble to learn the necessary steps of the operation. The reason for the opposite opinion, which has been so widely embraced by the profession, depends upon the belief that in this case the prerequisites to success in any other operation, i. e., a careful study of the parts involved, and practice on the cadaver, may be neglected.

After having studied the parts in a half head, and practiced the introduction of the catheter upon this, you may proceed to introduce it in the head of a subject which has not been divided. The position of the catheter may be ascertained and regulated by passing the finger behind the soft palate through the mouth. After all this has been

[1] Löwenberg, Archiv. für Ohrenheilkunde, II, S. 12.

passed through, we should practice the introduction of the instrument on ourselves.

The correct position of the instrument may be known by the following named conditions: In speaking and swallowing it remains immovable. The beak cannot be turned any farther upward, and the air that is blown in, is felt in the ear, or at least toward or against it. For the purpose of forcing in the air, a gutta percha air bag may be used, or the air may be blown in through a gutta percha tube, with a nozzle on each end; one of which is placed in the mouth of the surgeon, and the other in the funnel-shaped extremity of the catheter.

FIG. 18.

Gutta Percha Air Bag.

I cannot sufficiently recommend practice with the catheter on yourselves. To the physician, who in his avocation is so much exposed to colds, occasion is very often furnished to employ this instrument for its appropriate use; that is, for the purpose of retaining his hearing power.

When the catheter is properly introduced it causes no pain. The majority of patients speak only of an unpleasant sensation, of a tickling in the throat, while the operation is being performed for the first time. On repetition of the operation all these unpleasant feelings disappear. They occur at the first time, because we are dealing with parts that are scarcely ever touched. When there are natural hindrances to the passage of the instrument, abnormal narrowness of the canal, &c., the operation cannot be performed without pain; but these are exceptions. More inconvenience is caused when the instrument

is introduced with uncertainty and want of skill, and the mouth of the tube is not readily found. Although we very often find catarrh of the cavity of the tympanum connected with catarrh of the pharynx, the unpleasant sensation in the nose and pharynx scarcely ever amounts to pain; and it is only in cases of great irritation that fits of coughing occur. The sensitive membrane soon becomes accustomed to contact with the instrument, and we can soon pass from a slender and slightly curved one to a larger.

Sometimes it happens, especially at the first trial, in very sensitive and anxious patients, that a spasm of the muscles of the pharynx and palate occurs, and the instrument, if not already in the mouth of the tube, is held fast, and prevented from any further motion, while, from the severe pressure on the mucous membrane, severe pain is caused. The surgeon should then endeavor to quiet the patient, endeavor to induce him to open the spasmodically closed eyes, and look calmly about, while he lightly turns the catheter into the proper position. The patient must neither speak nor swallow before the instrument is in the entrance of the Eustachian tube. The quieter and more confiding the patient, so much the easier is the operation for the surgeon. The more decided the surgeon is in his manner, the less time he wastes in telling what is about to be done; the easier, especially with nervous patients, will the operation be performed.

As to other accidents that may occur, besides the spasm just spoken of, we may first speak of emphysema of the neck, which has been very much feared, occasioned by air passing through a perforation of the mucous membrane. In the greater number of instances the emphysema occurred where the catheter had been often introduced, and where no unpleasant symptoms had previously occurred.

On the cadaver we quite often find erosions, and trifling

ulcerations about the mouth of the tube. These are not to be diagnosticated without the rhinoscope, and may easily lead to emphysema. It is very evident that any want of delicacy of contact with such an already abnormal mucous membrane may easily produce its rupture. It is also well not to give the ear an air bath immediately after the introduction of catgut bougies into the tube, for the membrane may be easily ruptured by them. These air tumors of the neck affect the swallowing, and alarm the patient. In the most cases all the symptoms disappear in the course of a day. I saw one case, however, where the emphysema produced difficulty in swallowing that lasted for five days. One of the patients very naively remarked, that his neck felt like veal that had been blown up by the butcher. It will be best to divide one of the vesicles on the uvula with the scissors or knife, should the emphysema occur, and thus give an exit to the air, and immediate relief to the patient. *Turnbull*, of London, is said to have lost two patients, some twenty years ago, from the use of the Eustachian catheter. Even if the compression pump were too strongly filled (he had intrusted the filling to the patient), it is hard to see, from the published account of the autopsy, how the accident occurred.[1] (It is said that Turnbull used a long instrument, and that he caused it to produce a rupture of the laryngeal mucous membrane. St. J. R.)

We know how common a thing is hemorrhage from the nose, and that in some people it is induced simply by a severe fit of sneezing. We need not be surprised, then, that the catheter is sometimes tinged with blood, or that slight hemorrhage occurs, when not the slightest pain or inconvenience has been caused. If such bleedings return or continue, a solution of alum, gr. ij ad aqua ʒi, may be snuffed up the nose, and this will probably soon check the

[1] See M. Frank's Handbuch der Ohrenheilkunde, S. 173.

bleeding. The irritation of the nasal mucous membrane, caused by the catheter, often produces an increased secretion of tears, which run over the cheeks, when not the slightest pain has been caused.

It is necessary to have several instruments in order to be successful in the introduction in all cases. It has been very much insisted upon, that the instruments should be of different caliber. According to my idea, it is much more important that they should be differently formed as to the length and curvature of the beak.

These latter named variations are most important with respect to the varying breadth and hight of the inferior nasal meatus, and as regards the distance between the posterior end of the nasal septum and the mouth of the tube, which varies very much in different persons.

The catheters which I generally use measure 3 mm. in caliber; at the beak, 4 mm. I use one smaller when the nasal meatus is very narrow, or in the case of children; its caliber is then from 2 mm. to 3 mm. The accompanying sketch represents the largest instrument. Three of different sizes are sufficient for all cases. We may give the catheter any curvature we wish, having first taken the precaution to draw a wire through it. (This presupposes that the instruments are made of pure silver. My experience causes me to use only instruments made of alloyed silver, where no bending is allowed. Otherwise they are apt to bend, when yielding is not desired. St. J. R.)

The effect is always more powerful, when a catheter with a large curve, and of quite large caliber, is employed. It is also well, during the blowing in of air, to press the catheter somewhat on the nasal septum, which enables it to enter the mouth of the Eustachian tube more deeply. The more the point of the instrument is enclosed by the walls of the tube, of course the greater the effect through the catheter. In some cases, the current of air

enters the ear most powerfully, when, without displacing the catheter, it is drawn from its original position in the mouth of the tube slightly forward toward the operator. By no means unfrequently two sorts of catheters are necessary for the two sides, in one patient.

Elastic catheters are much less to be recommended than silver ones. We cannot have as certain a touch with a flexible instrument. If, perhaps, we pass through the nasal meatus more easily, it is more difficult to find the mouth of the tube with them. Comparative experiments have also shown that the stream of air through an elastic catheter is not so strong upon the ear as that from an instrument made of unyielding material.

This may depend from the fact that we are not so certain of pressing upon the lowest portion of the tube with a flexible, as with a firm instrument. Besides, silver tubes, as a rule, can be easily introduced and without pain. I prefer them to the hard rubber ones very recently recommended by Politzer.

It is necessary that a surgeon who has many aural patients should have a large number of catheters, in order that he may not be compelled to use the same instrument on different persons before it has been thoroughly washed with hot water. Syphilis has been several times transmitted, especially in Paris, through the Eustachian catheter. I would also advise you to blow through a catheter before introducing it into the tube.

LECTURE XIV.

THE PRACTICAL VALUE OF CATHETERIZATION OF THE EAR.

Diagnostic value; auscultation of the ear; the otoscope and air bath; manifold use of the catheter in the treatment of diseases of the ear; effect of the air bath; the catheter as a vehicle for introducing gaseous and solid substances into the middle ear; rubber air bag; compression pump; instrument for holding the catheter in position.

GENTLEMEN: After having learned the mode of introducing the Eustachian catheter, the question occurs—what is the practical value of catheterization of the ear, and in what cases may we employ it? A general answer may be made as follows; Its use is so to open the Eustachian canal and cavity of the middle ear in order that we may produce a direct effect upon them by remedial agents. It is not possible to do this by other means, except when there is a loss of substance in the membrana tympani, and thus the middle ear is in part exposed.

The Eustachian catheter is only a means of introducing agents into the cavity of the tympanum. It, of itself, will accomplish nothing, although some medical men, who content themselves with introducing it into the nose and pharynx, or even the mouth of the tube, and who then immediately withdraw it, seem to believe that it has some specific virtue of itself. By the mere introduction of the instrument, at the most, some mucus may be removed from these parts, or the walls of the lowest portions of

the tube be somewhat pressed apart. This, however, as a rule, accomplishes very little.[1]

The effects of the catheter upon the middle ear have a relation to the diagnosis, as well as the treatment, of diseases of the ear. We must therefore consider catheterization from these two points of view.

Let us first speak of auscultation of the ear. *Laennec* described this in his treatise on the general subject o auscultation,[2] where he devotes an entire section to th special theme. Auscultation of the ear allows us to form some conclusions as to the condition of the tube, as wel as of the cavity of the tympanum.

Physicians generally assert that the ear is inaccessible i a diagnostic as well as a therapeutic respect. It is onl true, however, that in some respects it is less accessibl than some other organs. When we desire to auscultat the lungs or heart, we simply place our ear upon the ches of the patient, either directly or by means of a stetho scope, and in this manner we may listen to the variou sounds. In auscultating the ear, the matter is not quit so simple. Here we need for the same purpose bot skill and a certain apparatus. We must first introduc the catheter into the mouth of the tube, and then produc an artificial current of air, in order to form our dedu tions. For this latter purpose we may blow the air fro our own lungs through the mouth, or by means of a india-rubber air bag. We may also induce the curre from a compression pump, gasometer, or the like. Th sounds thus excited in the ear, the surgeon may hear b placing his ear directly upon that of the patient, or mo

[1] *Philapeaux*, of Lyons, employs such a method. He passes a probe with an oli shaped beak through the nose, and introduces it as far as possible into the tube, about 1 2 1-2 in. *Du cathétérisme de la trompe d' Eustache à l'aidé bes cathéters a boule.* Ly 1859.

[2] Traité de l'auscultation médiate. Paris, 1837. 4 edition T. III, p. 535.

conveniently by means of a stethescope adapted for this purpose.

Toynbee, in 1853, suggested the use of an elastic tube with two tips, with which to auscultate the sounds produced, in the ear, when a motion of swallowing is made, with the mouth and nose closed. He called this tube, the otoscope. The name is a very good one, as well as the instrument. We retain both, but we enlarge the applicability of the latter.

FIG. 19.

Otoscope or diagnostic tube.

(It may be suggested that the name otoscope is better adapted to the mirror for examining the membrana tympani, just as the one for examining the throat is called the laryngoscope, that for the eye, the opthalmoscope, etc. It is better to call the so-called otoscope a diagnostic tube, as Kramer suggests. St. J. R.)

If a powerful stream of air pass through an Eustachian tube of normal size and having a normal degree of moisture, it creates a sound which *Delau* likens to the falling of rain upon the leaves of a tree, and therefore calls "bruit de plaie." I would rather call it a vesicular murmur, or if the force of the air be very great, a knocking sound (*anschlage geraüsch*), because we hear the stream of air striking a dry,

elastic membrane—the drum—and pushing this somewhat outward. The sound passes through the otoscope, or tube, and seems to the examiner to be very near him. The patient will exclaim that the air is passing through the ear, whereas it has only entered it. If the mucous membrane be smeared with the normal secretion, the sharpness of tone is somewhat mollified—it becomes soft, not to say moist. Sometimes this knocking or rapping sound seems very hard and dry. It is then usually accompanied by a peculiar dryness of the mucous membrane. We then may conclude that there is a want of mucous secretion, such as is often found after an inflammatory process has been going on, and also in old people. It may also be often accompanied by great permeability of the tube. If the membrana tympani has been very much thickened, or is very much sunken, this knocking sound is particularly marked. If the Eustachian tube has been obstructed through swelling of its membrane, the air enters, instead of in a full, strong stream, in a thin, weak and interrupted one, and often with a whistling sound, striking most strongly on the membrana tympani when the patient swallows. Frequently we hear the air enter only during the act of swallowing.

In these cases, when not swallowing, the patient does not feel the air in the ear, but towards it, because the stream

results from a fluid gently moving to and fro, or from a more viscid one, and whether the rattling sound occurs only at the beginning of the air bath, or at every repetition.

Certain loud, rattling sounds are even better recognized without the otoscope or diagnostic tube than with it. They arise from the entrance of the tube, at its pharyngeal orifice. Frequently a loud, piping, trumpet like sound is mingled with them, if the cartilaginous portion of the tube projecting into the pharynx is placed in lively motion, as is often the case, even when the catheter is in the proper situation.

Mucous glands are very numerous at the pharyngeal entrance of the tube, so that we may distinguish their openings with the naked eye, and on the dead body we find a greater or less amount of glairy mucus deposited in them.

We often hear a very near whistling, or loud hissing sound, if the membrana tympani has a very small perforation, and we then find a drop or so of pus or mucus in the meatus, which has been driven through this hole from the cavity of the tympanum.

If, at the same time, the otoscope or diagnostic tube is placed air tight in the auditory canal, an increased pressure is felt upon the membrana tympani of the listener. The same sensation may be experienced when a large portion of the membrana tympani has become very much thinned. This "perforation murmur" is not generally present when the perforation is very large, or when there is no purulent or mucous secretion. If we hear only a far removed and indistinct sound, with the otoscope, we may refer it to various causes. The catheter may not be in the right position. If this be the case, the patient will have a feeling as if the air passed in his throat and nose, and a reintroduction will produce quite another sensation.

The catheter may, however, be placed properly, but the current of air may meet with some impediment. The end may be covered by a fold of mucous membrane at the mouth of the tube, and the free passage of air be prevented. The tube may be also obstructed by swelling, or by a firm adhesion of its mucous surfaces, or by dried secretion, not to speak of the very rare cases of cicatrization of the mouth of the tube.

Auscultation may also produce a negative result, although the catheter is in the proper position, and the tube permeable, if the curvature of the beak is not in proper proportion to the lateral portion of the pharynx, and it does not lie between the lips of the tube. The same negative result may occur when the cavity of the tympanum is no longer an air reservoir, whether filled by thickened secretion, or its walls lie in contact from swelling of its lining membrane, or adhesion of the opposite surfaces.

All these conditions we shall study more closely at a subsequent period. An examination with the ear mirror (otoscope) will generally give us an idea as to the nature of the different conditions which may produce these negative auscultatory results.

Frequently, however, even with the greatest amount of skill and practice on your part, exerted on the most intelligent and tractable patients, the first examination with the Eustachian catheter will leave much to be decided at a second sitting, as to the condition of the cavity of the tympanum and the tube. Of course here, as in all other modes of examination, the less skillful and practiced is the examiner, the less intelligent and tractable the patient, the less will be the diagnostic results that the catheter will furnish. As a last resort, rhinoscopy, or the examination of the upper part of the pharynx, must be undertaken to determine whether the improper position of the catheter

or an abnormal condition in the ear, for instance, an adhesion of the walls of the tube, is the reason that the air does not enter.

Catherization of the tube furnishes diagnostic conclusions to the eye as well as the ear. If we examine the membrana tympani during the so-called air bath, we may perceive that this membrane is variously affected in different cases, even when the stream of air is of the same degree of strength. Sometimes its whole surface, with the handle of the malleus, is moved outward very much, again it is feebly and slowly moved in some parts, while others remain fixed, or even appear more tense. We may only indicate these symptoms at this point, since we shall return to them in speaking of catarrh of the cavity of the tympanum, and consider them more at length.

By repeatedly testing the hearing distance, and examining the appearance of the drum during the air bath, we may draw a number of deductions, not only as to what extent the tube is permeable, and as to the secretion, but we may also determine how far the impairment of hearing or the tinnitus aurium may depend upon a closure of the tube, or upon other conditions in the ear that act in a mechanical way. Some of these are collections of mucus, rigidity of the membrana tympani, etc. Such conclusions will have quite a deciding influence upon the diagnosis, prognosis, and future treatment.

As has been already mentioned, the patient generally feels the stream of air "in the ear," or "going out of the ear." This sensation of the patient, and the visible movement of the membrana tympani during the air bath, or douche, are not always in exact proportion to each other. It may be that the patient does not feel the current of air in the ear at all, and yet it forces the drum outward. I remember one case, that of a reliable patient, who, after a treatment of several months, declared that he

never felt the air pass into one of his ears, while he always had the ordinary sensation in the other, and yet the movement of the drum was greater on the former side than the latter. In this case there was complete loss of sensitiveness or an anæsthetic condition of the nerves of the cavity of the tympanum and the membrana tympani. Such cases, although of different degrees, are not very rare.

The catheter is, however, of much more value in the treatment, than in the diagnosis of aural disease. We may inquire, then, what good does the use of the catheter accomplish, and how may we employ it? In order to meet any preconceived opinions on this subject, we may answer these inquiries by a simple reference to facts.

If we examine the membrana tympani while a powerful stream of air is blown in through a catheter properly introduced, we see, in all cases where very great resistances are not met with, that the membrana tympani is moved more or less outward into the auditory canal. At the same time we not only hear the current of air strike the drum, but we may also convince ourselves, objectively, by the sense of sight, that the air not only actually enters the cavity of the tympani, but that it also exercises a certain mechanical effect upon this part.

It is evident that if there is such an effect on the membrana tympani, there must have been a considerable effect while the stream was passing to it. The walls of the Eustachian tube are not only separated from each other, but all hindrances to the passage of air in it, and the cavity of the tympanum, such as mucus and pus, will be put in motion by the current, and driven either into the mastoid cells, or into the throat. This air bath, for we may so designate it, acts as a cleanser of the Eustachian tube, and of the cavity of the tympanum, and restores the connection between the throat and the latter, if it

has been interrupted from any cause. Moreover, as we may see, the membrana tympani is moved outward, and thus any abnormal adhesions of this membrane must of necessity be stretched, and under very favorable circumstances be even loosened. This last named purely mechanical influence on adhesions in the cavity of the tympanum, we may verify[1] by observations on the cadaver. A consideration of the effect of a douche, as observed upon these adhesions, will convince you that we may quite often loosen a synechia in the cavity of the tympanum. Such an effect occurs in those cases where a single introduction of the catheter has been of great use in restoring hearing; cases which have hitherto been called "accumulations of mucus in the middle ear." This effect of the air bath, which is quite common, because the adhesive process in the cavity of the tympanum is among the most frequent of the pathological conditions in the ear, has been hitherto entirely overlooked by aural surgeons. We may only explain the oversight by considering the neglect of an examination of the membrana tympani, and the insufficiency of the previous methods of illuminating the ear. We should never omit, after the employment of the air bath, or douche, to examine the ear very carefully, because we are thus enabled to see what effect we have produced, and on what anatomical conditions the improvement in hearing depends.

Up to this time all the observations which have been made as to the effect of condensing or rarefying the air in the cavity of the tympanum, have been referred to the effect produced upon the membrana tympani alone, as if it were not a mechanical law that an effect should be produced in all directions where the stream of air passes. Politzer was the first to show the one-sidedness of this view, one-sidedness in the strongest sense of the word, and he

[1] Vide Virchow's Archives, vol. 17, sec. 5.

showed, experimentally, that each rarefication or condensation of the air in the cavity of the tympanum must act not only on the membrana tympani, but also on both the fenestræ, because their elastic coverings, the membrane of the fenestra ovalis, and fenestra rotunda, with the membrane surrounding them, must be thereby distended.

Repeated introduction of streams of air will remove a recent or commencing rigidity. It may possibly break up an anchylosis of the stapes, and restore the lost elasticity of the membrane of the fenestra rotunda. These adhesive processes occur very often in these parts, and their occurrence has such a great effect in diminishing the hearing that the use of the catheter becomes very important.

It is evident that even when the pressure of the air is the same, the effect upon the fenestral membranes may be different, according as the movements of the membrana tympani are free or restricted, as it is abnormally relaxed and very movable, or greatly thickened and fixed. If we intentionally lessen the excursive power of the drum during the air bath, by pressing a finger into the external meatus, or by filling the auditory canal with water, the head being inclined to one side, the mechanical effect of the douche will be more strikingly felt upon the elastic portions of the labyrinth wall of the cavity of the tympanum. In certain cases this effect is much to be desired.

Among the interesting appearances after or during the air bath, are mucous vesicles in the cavity of the tympanum, whose outlines may be seen through the membrana tympani. *Politzer* has recently described a case of collection of serous fluid in the cavity of the tympanum. The hight to which this arose was indicated in the membrana tympani by a hair-like black line, which moved downward when the patient exchanged his upright position for a horizontal one. I saw a similar change of position of the bubbles of mucus, in two cases. During the air bath quite a large vesicle, reaching into the

auditory canal was formed from the posterior and upper portion of the drum, which in one case had somewhat the appearance of a raspberry, and which in both cases extended over the end of the handle of the malleus, as it were, covering it. In both cases there were decided evidences of abnormal adhesion of this portion of the membrana tympani. After each air bath the same shaped vesicle formed, without any pain, but with marked improvement to the hearing. It disappeared in about half an hour. I can only explain this rare occurrence by supposing that a small loss of substance has occurred in the membrana tympani; that a small hole exists in the mucous and fibrous layer, allowing the passage of the air under the superficial integumentary layer.

(Dr. Weir, surgeon to the Eye and Ear infirmary of this city, has furnished me with the notes of a case where, after an inflammation of the cavity of the tympanum had lasted one week, "the membrana tympani was thickened and reddened, but partly transparent, and through it is seen, on the Valsalvian experiment, a bubble of air, rising and falling. Air entered, as heard by the diagnostic tube, slowly, with little crackling sound. Frequent inflation of the drum caused the ear to feel better, and the hearing was improved." The observation was again verified, and the patient made a good recovery. I once saw a patient of Dr. C. E. Hackley's, also a surgeon to the infirmary, where the integumentary and fibrous layers of the drum were absent at one point. The passage of the air into the cavity of the tympanum caused a flapping sound. St. J. R.)

I would take this opportunity to speak of an objection which older members of the profession make to the use of the catheter. Many fear to use it because they believe it is very easy to blow mucus from the throat into the cavity of the tympanum, and thereby cause injury. I do not doubt but that this sometimes occurs at first; but if we do not stop at a single blowing, the mucus will certainly come out again into the throat, or into the cells of the mastoid process, which lie on the same plane with the entrance of the Eustachian tube into the cavity of the tympanum. Consequently the course and power of the stream of air must be directed against these cells. I have never

seen any injury produced from blowing air into the cavity of the tympanum, although I have introduced the catheter a countless number of times. We should call to the recollection of these theoretical gentlemen the fact, that the catheter is much smaller than the pharyngeal entrance of the tube, and that consequently it is not tightly held in the opening, and that there is always a large returning stream of air, in which all the moving bodies will fall which lie beyond the bony portion of the canal. The tenacious mucus which is in the throat will certainly, therefore, be oftener blown into the throat than the ear.

There are other objections, such as that the catheter irritates the mucous membrane, a view which *Toynbee* also takes, but these are still less reasonable, and they have no force until some one wishes to use the catheter who knows nothing of the *modus operandi* of its employment. Generally speaking, *Rau's* remark may be applied to these cases of fear of the use of the Eustachian catheter, when he says: "The principal objection of most opponents rests in their want of dexterity in the use of the instrument."

The effects of catheterization, which we have hitherto observed, are generally transient in their nature, or at least they gradually diminish in importance. We generally desire to secure a lasting influence on the affected membrane of the middle ear, for, after the removal of the secretion, or the separation of the opposing surfaces, the mucous membrane will still remain affected. Local treatment is only possible by means of the Eustachian catheter; it serves as a vehicle for introducing various remedies, which act directly on the tube and on the cavity of the tympanum. Such medicaments are employed either in the form of fluids, or of vapors or gases, of whose value we shall subse-

quently speak in detail, in the lecture on chronic catarrh of the ear.

We have still to mention that the catheter may be used as a vehicle for the introduction of solid bodies into the tube, and possibly into the cavity of the tympanum. Such bodies are probes of metal, whalebone, or catgut, or copper wires, for transmitting electricity. We shall learn the special value of the introduction of these instruments at a later period.

We generally use a gutta percha bag or syringe for the purpose of forcing medicated fluids or vapor into the ear, the nozzle of this being inserted into the funnel-shaped orifice of the catheter. The custom of blowing the air into the catheter from the mouth of the surgeon, as may be done when we wish to give a simple air bath, is a method not to be recommended for introducing these agents, even if there be no bad odor in the breath. In cases where the resistance from the walls of the tube is unusually great, a fact easily recognized by the hand which compresses the air bag, or when from any other reason a more powerful current of air seems desirable, we may advantageously use a compression pump, not only for the air bath, but also for the subsequent treatment with vapors and gases, or with injections. (I have entirely abandoned the use of the compression pump, after a brief and unsatisfactory experience with it, and use only the air bag, which I find to answer all purposes. St. J. R.) The compression pump which I use consists essentially of a quite thick glass bell, forty centimetres high, and twelve broad, which is fastened on a wooden support by means of a strong measuring tub. There is connected with this a pump twenty centimetres long and four centimetres in diameter, which, with its wooden support, rests on the table. In the tube which connects the ball with the pump there is a faucet which has an opening for the entrance of external air, and is besides

perforated by a horizontal opening, through which the air pressed by the pump passes. The faucet for the regu-

Fig. 20.

Air Receiver and Pump.

lation of the exit of air, is on the top of the bell, and there is a gutta percha tube added to it, which leads the air into the catheter or heating apparatus. The measuring tube at the bottom of the glass bell is fastened on by a screw, which must be air tight, and admit of removal for cleaning. I have tried very many apparatus, and I believe the one which I have just described is the best. Air bags, single and double, are used by many physicians instead of the pump. Some use hand bags, and others those that are so large as to be placed under the table and moved with the foot.

Very recently, Lucæ, of Berlin, proposes to use two air ıgs, one of which is of thin rubber, and, having a venti-

lator, acts as an air reservoir. Usually, however, a simple unvulcanized air bag, vigorously compressed by the hand, is sufficient. I now make infrequent use of the

FIG. 21.

Glass Flask for generating vapor.

pump. I use a simple glass flask for the generation of the vapor, which is placed on a sand bath, and heated by means of a spirit lamp. The cork of the bottle is bored in four places, one for the funnel-shaped glass tube, to which a stopper is adjusted, one for a thermometer, and the remaining two for the entrance and exit of the heated air, conecting respectively with the gutta percha tube from the pump, and with the catheter. In order to steady the flask an iron support passes around it.

(Dr. Moos, of Heidelberg, recommends a method of introducing the vapor of muriate of ammonia which the accompanying figure and description will make clear.

FIG. 22.

Apparatus for generating muriate of ammonia.

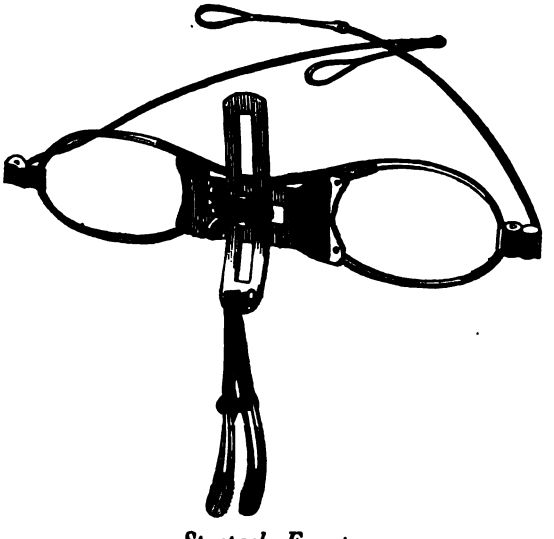
The apparatus consists of three glass flasks, two of which contain hydro-chloric acid and ammonia. They each have a cork with two holes in it; one for the tube leading in, and the other for the tube leading out of the flask. The third glass flask contains compressed air, in which hydro-chloric acid and vapor of ammonia are combined, and in which the vapor of ammonia is found *in a state of generation*, and which necessitates a third cork having three holes in it, because from hence the vapor is driven out through the conducting pipe that leads into the catheter. The tubes of the first two flasks (*a* and *b*), when they unite with the tube of the pump, may be very properly united in one by means of a fork-shaped tube made of horn. St. J. R.)

Generally the catheter may be held with the hand of the surgeon, after it has been introduced into the mouth of the tube; at the same time it is well to place the left finger on the cheek or nose of the patient.

When the patient is intractable or awkward, or when the catheter is to remain a long time in its position, we should fasten it by some mechanical contrivance. A number of instruments have been proposed for this purpose.

Kramer's frontal band was formerly most frequently used for this purpose. This consists of a small, roundish pad resting on the forehead, to which a screw forceps is attached by means of a ball and socket joint.

FIG. 23.

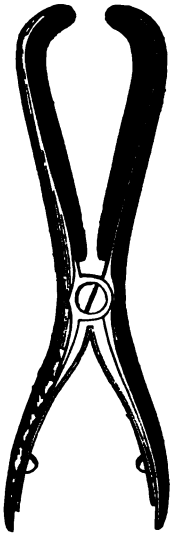


Spectacle Forceps.

Rau advises the use of a spectacle forceps, that is, a spectacle frame with a forceps attached, which may be fastened in any position desired by means of a screw and slide. Very recently I have used a nose pincers, first suggested by *Bonnafont*, and modified by *Lucæ*.

If the catheter be properly introduced and fastene patient will be in no manner prevented from sw ing or speaking. He is generally able to sneeze wi displacing the catheter. In fact it may remain for if necessary.

FIG. 24.



Nose Forceps.

LECTURE XV.

Valsalva's and Politzer's method of inflating the middle ear; other inferior methods.

GENTLEMEN: We may to-day pass in review a number of methods of inflating the middle ear that may in some cases, at least, accomplish results almost identical with those which are obtained by catheterization of the Eustachian tube, or which may act as substitutes for this procedure.

The Valsalvian Experiment.—Valsalva's experiment consists in pressing the air into the ear, after a powerful inspiration, the mouth and nose being closed. This method is termed, by the English, blowing up or inflating the membrana tympani. It is of a certain value in the treatment of the patient by himself, as we shall have occasion to learn. It causes a sort of condensation of the air in the cavity of the tympanum, and the membrana tympani is at the same time generally pushed somewhat outward. This pushing out of the membrane may be most distinctly observed on the posterior and upper border, at the extensive reflection of light there existing.

In examining patients, however, for the purpose of diagnosis, you will seldom have occasion to make use of this method. In very many persons, especially those very hard of hearing, it will certainly take more time and trouble to teach them this method than is necessary for the introduction of the catheter and the employment of the air douche. In employing the Valsalvian method we are limited to the statement and reliability of the patient as to whether the air enters the ear or not, unless we can

at the same time examine the membrana tympani, wh we are not always able to do at the first attempt. Furth more, even if the experiment succeeds, we learn noth except that the tube is permeable. We obtain no furt idea from it of the state of the tube, or of the middle e In some cases, however, a loud whistling or hissing sou is noticed during the inflation, when the catheter and douche do not show any symptoms of increased secreti of mucus.

Not unfrequently patients believe that they are affect with a perforation of the membrana tympani, because th can produce such a whistling sound in the ear, which h a certain similarity to the sound of air passing through perforation. But it is also true that some patients w have known how to use this method for a long time, not able at times to force the air into the ear, while a v orous blowing in of the air through the catheter sho that the tube is permeable.

The diagnostic value of the Valsalvian method, compared with that of the catheter, must be regarded very little. It may be rather considered as an assistance be used in a case of necessity, but as a means which is to be relied upon. I may also call your attention to fact that not a few patients practice this method very properly, although they imagine that they understand very well, because they have been accustomed to emplo very frequently for physicians who do not willingly use catheter. Instead of simply forcing the air in, a half sw lowing, half sucking movement is made, by such perso so that the air is not only not rendered denser, but it is ac ally rarified. I have observed a few cases where, in the p formance of this experiment, the air passed out through lachrymal punctum, and the patients only felt the air in ear, when the finger was pressed upon the inner canthus the eye.

Toynbee believed that we were able to fully dispense with the catheterization of the Eustachian tube, as a diagnostic aid. He endeavored to determine the permeability of the tube by means of a method which may be called the *negative Valsalvian experiment*. He caused the patient to swallow while he auscultated the ear with the otoscope, or diagnostic tube. If the Eustachian tube is permeable, a sensation of fullness in the ear is experienced, a peculiar cracking sound is said to be heard, which is not the case if it be closed. *Toynbee* himself, however, confesses that the sound is sometimes wanting, when we know by other means that the tube is permeable, and that it may occur when other signs indicate that the tube is closed. In short we have only to read the testimony of the author,[1] to convince ourselves how unreliable for diagnosis, and how little to be trusted, this method is. *Toynbee*, who was the founder of the modern system of the pathology of the ear, was in error in not employing catheterization of the ear in the examination, and unfortunately also in the treatment of aural diseases.

Toynbee's method, however, has its uses. If we look at the membrana tympani while the patient swallows with his mouth and nose closed, we find a variable condition of the membrane. It is shown by manometric experiments that a rarefaction of the air in the cavity of the tympanum then takes place. Sometimes the anterior and inferior segment of the drum moves outward, but it is more commonly drawn inward, while its upper portion is pushed out, and again it does not move at all, although the tube is permeable both when the catheter is employed, and when the patient himself presses in the air. Such movements are sometimes perceived with this experiment, when the Valsalvian experiment produces only a negative result.

[1] Diseases of the Ear, p. 196.

In partial atrophy of the membrana tympani, especially in cases where large perforations have been healed, such movements are seen on the thinned portions of the membrane, as often as the motion of swallowing is made, even when the nose is not closed.

Politzer's Method.—We may now turn to the consideration of a very important method of inflating the cavity of the tympanum, which is called after the name of its inventor, *Politzer's method.*

This method was suggested by Dr. *Adam Politzer*, of Vienna, in 1863. It consists essentially in the following: The air is forced into the nasal cavity by blowing from without at the same instant that the patient swallows. The air in the naso-pharyngeal can only be rendered denser, of course, when this space is changed into a closed cavity. This is effected by the surgeon, anteriorly, who closes the nasal passages by pressing them together with the fingers. The cavity is closed posteriorly by the act of swallowing, during which the upper pharyngeal space is shut off from the lower by the soft palate, which lies back against the pharynx. The act of swallowing also causes the pharyngeal orifice of the Eustachian tube to open. Thus a way is opened by which the entering stream of compressed air meets with but slight resistance to its entrance through the tube into the cavity of the tympanum.

The manipulations necessary in carrying out this method
tremely simple. A straight or slightly curved tube
ntroduced into the entrance of the nasal meatus,
f an inch. Then the nostrils are both closed
sure with the fingers. We have then only
tient to swallow at the same instant that air
gh the tube. It is well to cause the patient
water in the mouth just before, in order
ble to swallow exactly at the proper time.
orced in by the mouth, or by the india

rubber bag. A slightly curved tip or nozzle may be connected to the india rubber bag by means of a piece of india rubber tubing.

FIG. 25.

Politzer's method of inflating the cavity of the tympanum.

In all cases where the resistance from the walls of the tube is not too great, the air in the middle ear is condensed by the above described procedure. The patient becomes aware of this by a certain pressure in the ear, and on examining the membrana tympani at the same time, it is seen to be bulged out externally, especially posteriorly and above. The diagnostic tube, or otoscope, rarely furnishes any conclusion as to the entrance of the air, because the sound produced by the muscles and the water drowns the slight sound occurring in the middle ear. When a perforation of the membrana tympani exists, a very loud whistling or hissing sound generally occurs, while at the

same time the secretion from the middle ear is driven into the auditory canal, and sometimes even to its outer extremity. The action of Politzer's method is similar to that from the air douche with the catheter, and to that of the Valsalvian experiment.

As compared with the use of the Eustachian catheter we notice especially the great and peculiar simplicity of the method. Any person may employ it with any other person, always excepting the very rare cases where the naso-pharyngeal space cannot be closed in consequence of fissure of the palate, etc.

There are none of the hindrances in the performance of this operation, either to the surgeon or the patient, that may arise in the use of the Eustachian catheter. As has been already said, cases sometimes occur where the catheter cannot be used without great pain or hemorrhage, on account of some abnormal condition of the nasal meatus. With the constantly increasing practice of the surgeon such cases constantly become more rare, and we may possibly introduce the instrument from the other side. But this roundabout way does not always allow the desired result to be accomplished, and it may be that both nasal passages are impermeable. For all such cases, we have found a substitute for the catheter in this new method, and a means of relieving ourselves from the unpleasant position of leaving a state of things unimproved which might perhaps be corrected, were it not for the accidental local conditions.

In the beginning of your practice you will not unfrequently meet with patients who make great objections to the use of the Eustachian catheter. In the case of healthy adults it will be proper to meet such persons with a quiet persistence in your determination to use the instrument when necessary. If you do not you will never acquire the

confidence of your patients, or obtain any experience in catheterization.

The matter is quite different, however, when you are dealing with children, or with persons who are very weak, or prostrated by constitutional disease. In these cases we were formerly obliged to forego any considerable local treatment, but we now have the means, in Politzer's method, at least in recent cases, of obtaining the same or similar curative results as with the catheter. Not unfrequently, at a later period in the treatment of such patients, when we have acquired their confidence, we may, if necessary, pass on to the use of the catheter.

Politzer's method of inflating the middle ear is much more important for the great mass of practitioners than for you, gentlemen. They, are generally not acquainted with the mode of using the catheter, and are apt to cause the patient a great deal of pain in introducing it, without doing him any good. It is of inestimable value to have a means for the use of such practitioners, which they can safely and certainly employ in certain diseases of the ear, and with which they may exert a favorable influence upon the course of the affection. We shall have occasion to speak of the great frequency of aural catarrh, especially as it occurs in a class of mild and severe constitutional affections, at a subsequent meeting.

This new method, finally, is extremely useful in those cases where we desire that patients should treat themselves. They easily learn how to employ it. Great care should be taken, however, in instructing patients. It is not sufficient to place an india rubber bag in the hands of the patient, but he should be taught not to rarefy the air in the middle ear after it is made denser, as is done by many, and even by physicians, by not closing the air bag when withdrawing it from the nose. Air bags and india rubber tubing are also sometimes used, that blow dust and other

substances into the ear. (It is well to caution patients who are advised to use Politzer's method, against its too frequent employment. I heard of one patient who injured her ear by using the air bag every hour for several days. St. J. R.)

It is only in rare cases that we can instruct the laity how to use the catheter. Patients who require that the air should be frequently and regularly forced into the ear, have been until recently limited to the Valsalvian experiment. This, however, is in very many cases very inferior to Politzer's method.

We may now inquire, how does the new method differ from that of Valsalva? Chiefly in the fact that it acts more powerfully, and more certainly accomplishes its object. In the Valsalvian experiment the pressure caused by the forcible contraction of the expiratory muscles, is distributed over the large surface of the thorax, and of the respiratory tract, with the upper and lower pharyngeal space, before it acts upon the walls of the tube.

In Politzer's method, on the contrary, the resistance of the adherent walls of the tube is considerably diminished by the action of swallowing. Besides, the surface on which the force of the condensed air distributes itself, is only the naso-pharyngeal space. It is therefore much smaller than when the Valsalvian method is employed, while the force exerted is much greater. Added to this, Politzer has already shown by experiment that the column of mercury in the manometer can be raised much higher by the pressure of the hand upon an air bag, than by the expiratory muscles. We need not be surprised, therefore, that we are unable to overcome resistances in the tube by the Valsalvian procedure, which the method of Politzer very easily accomplishes.

Besides the fact that the Valsalvian method is less powerful, there are other objections to its use. Our

ear patients are very frequently children, who can scarcely, unless they have passed a certain age, at least, learn to force the air into the ear. It is in infantile practice that Politzer's method furnishes its most brilliant results, since the friends of the patients can readily learn to employ it. We should not omit to mention, that a very considerable hyperæmia in the head and ear often occurs from practicing the Valsalvian experiment. This appears especially if, in spite of an intense exertion of strength, the resistance of the wall of the tube cannot be overcome. We frequently see the face of the patient becoming red during the exertion of the force, and the veins on the surface of the head and neck become more turgid and swollen in consequence of the hindrance to the return of the blood. The vessels of the membrana tympani also become more injected, as may be observed with the mirror. The patients also complain of increased noise in the ears, and of a painful sense of fullness in the head. Such an artificial congestion excited in old persons with atheromatous cerebral arteries, may not be an indifferent matter. In the case of an extremely myopic patient from the country, with a large posterior staphyloma of each eye ball, a severe frontal pain, beginning from the eye, with a very annoying sensation of sparks before the organ, always accompanied the performance of the Valsalvian experiment, so that I was compelled to cause him to desist from forcing air into the ear, lest a choroidal hemorrhage or detachment of the retina should occur. This method was unfortunately, then, the only means that this patient, who could but seldom come into the city, had of temporarily diminishing a very great impairment of hearing, and of preventing its increase.

Politzer's method is to be infinitely preferred to the Valsalvian experiment. The latter has but one advantage over the former, that is, that no other assistance than the hand is needed for its performance. The relations of the

new method to the catheter, however, are somewhat different. It can only be substituted for the Eustachian catheter under certain circumstances, although when these occur it is an extremely valuable substitute. If there be no hindrance, either in the condition of the parts, or the age or general condition of the patient, or, furthermore, in the skill of the physician, to prevent the use of the catheter, it will have for very many cases very great advantage. In others very much may be accomplished by Politzer's method alone.

There is a very considerable difference in the character and effect of the current of air, whether introduced by one method or the other. In forcing the air in through the catheter we have a current of air passing against the resistances in the tube, which gradually makes a way for itself, and which after a time acts upon the walls of the cavity of the tympanum, and whose force may be gradually increased. The degree of the effect may be varied in different ways, apart from the amount of pressure that may be exerted, by using a larger or smaller catheter as to caliber, or one with a longer or shorter beak, or by causing the patient to swallow as the air is forced in, and also by closing the nose at the same time.

In Politzer's method, on the contrary, the compression of the air is very sudden and precipitate. We are not able to regulate very efficiently the amount of force used, or to decide beforehand how great it will be. At the same time it acts not only on the middle ear, but on the extensive surface of the naso-pharyngeal space, with the adjacent cavities, in the frontal, superior maxillary and spheroid bones. If, therefore, we wish to get a current of air of long duration, as well as a high degree of the compression of the air, such as may be obtained by the use of the compression pump, we should never employ Politzer's method, because we cannot always succeed in overcoming great resistances by its use.

The sensation of pressure in the neck (Prellung) sometimes experienced in the use of Politzer's method, is extremely unpleasant. This chiefly proceeds from the soft palate, which undergoes a double pressure—above, from the compressed air, and below, from the water which is compressed by the muscles.

This sensation is sometimes felt by children after the operation, in the stomach, and may cause a severe pain in this part, or in the diaphragm.

I remember the case of a child of four and a half years of age, that came under my care, who much preferred the catheter to Politzer's method, on account of the pain in the stomach which the latter caused. This child always cried bitterly when it was desired to use Politzer's method, but submitted quietly to the use of the catheter.

(I have never attempted to use the catheter in very young children, because they make so much objection, until they learn just what it is, even to the introduction of the nose piece of Politzer's instrument into the nostril. I have despaired of succeeding in any attempt to introduce the catheter, which always produces an unpleasant sensation. I have never seen any of the cases of which the author is now speaking, although I am in the daily habit of employing Politzer's method on children. St. J. R.)

A more important disadvantage of the new method is that we cannot localize the effect. If the resistance in both tubes or tympanic cavities be exactly the same, the air rushes into both, but when the conditions are unequal the air always takes the course where the resistances are the slightest. This effect is most disturbing where one membrana tympani is perforated, or partially atrophied, because the compressed air enters one ear alone, or chiefly so, no matter in which nostril it is introduced. In all such cases we must necessarily use the catheter. Sometimes the influence of the perforation may be overcome by hermetically closing the external meatus by means of the finger, or the like.

In some cases the fact must be taken into consideration that in the use of the Eustachian catheter, it is only required that the patient remain passive, while in Politzer's method the assistance of the patient is necessary —he must swallow, and at a certain moment.

Lucae and Hinton state that they overcome this objection by compressing the air in the naso-pharyngeal space by blowing through an elastic tube for some seconds at a time, allowing the patient to swallow the water at the instant he may choose.

Patients afflicted with diseases of the ear are not specially noted for quickness of perception, but on the contrary every physician who has much to do with this class of persons, knows how many awkward people are found among them, apart from the difficulty of instructing any person who hears badly, or is deaf, in the necessary manipulations for a successful employment of Politzer's method. It should, however, be remarked here, that it is only in adults that the simultaneous act of swallowing is an *essential thing*. In small children, very often, if not always, the compressed air passes from the nasal cavities into the ear without this assistance. The absolutely greater width, or more properly the greater capability of distension, of the infantile Eustachian tube, may be the cause of this exceptional condition, which increases the value of Politzer's method of inflating the middle ear, for practice among children.

Finally, the new method can by no means limit the value of the Eustachian catheter as a vehicle for the introduction of solid bodies, e. g., bougies, or for injecting fluids or vapors into the ear.

By first filling the air bag with vapor, or fluid, we are of course able, on closing the nose and causing the patient to swallow, to inject some of it into the ear. There are, however, other disadvantages attached to this method than

the one that in the procedure a great portion of the vapor is precipitated on the sides of the syringe. The diffusion of this vapor on the whole naso-pharyngeal space is by no means an indifferent matter. Besides, the force with which we thus inject fluid into the ear must be quite great. The effect of this unelastic body may easily be too great, and more than can be previously estimated. The observations of *Saemann*, who first recommended the injection of water by means of Politzer's method, under the name of "water douche of the Eustachian tube," sustain the above opinion. Together with a number of cases where this method of treatment proved very favorable, without any unpleasant reaction worth mentioning, he also observed cases where vertigo and a sensation of faintness, severe pain in the ear and in the mastoid region occurred, together with a worse condition of the hearing, lasting for several days.

Very recently Joseph Gruber[1] has recommended a method of inflating the middle ear that may be designated as a development of the Valsalvian experiment. It is especially recommended for cases where the naso-pharyngeal mucous membrane is affected, as well as the ear. While the patient holds the head in such a manner that the nasal meatus has a horizontal direction, a medicated fluid is injected into one nostril by means of a syringe holding about an ounce and a half. In the case of children it is only necessary to shut the other nostril, when, as a rule, a portion of the fluid that has been injected will pass through the tube into the cavity of the tympanum, and when the membrana tympani is perforated will even run out of the auditory canal, especially if the act of swallowing be performed at the same time. In adults, where the narrowness of the tube is not so favorable for this method, a blowing motion is made by the patient, with the mouth and nose closed, immediately after the injection, which

[1] Deutsche Klinik, 1865, Nos. 38, 39.

forces a portion of the fluid through the tubes, into both cavities of the tympanum.

The modification of the air bath before alluded to (page 188), in which we endeavor to make the membrana tympani as rigid as possible, by external pressure, in order that the membranes of the fenestræ may feel the more powerfully the mechanical influence, also applies to the Valsalvian and Politzer's method. In practicing the former the two thumbs are pressed powerfully on the ears, while the nose is closed by the middle finger. In the latter method the auditory canal is closed by the finger of a third person, or by means of an india-rubber stopper.

We may here notice a little instrument adapted especially for physiological demonstration of the vibrations of the air in the middle ear, as well as to show the permeability of the Eustachian tube, the influence of the acts of swallowing and respiration upon the membrana tympani, etc. It was first suggested by *Politzer*. It consists of a horseshoe shaped glass tube 1 1-2 mm. in caliber, which

FIG. 26.

Politzer's Manometer.

is fastened in the auditory canal by means of a hard rubber nozzle smeared with grease. A drop of a solution of carmine, contained

in this aural manometer, indicates, by rising and falling, the variations in the pressure of the air in the auditory canal and cavity of the tympanum.

According to Lucae it is very difficult to keep the manometer in position. He therefore uses a gutta percha tip, for introduction into the meatus, that has been previously warmed. This will not become looser even by repeated motions of the lower jaw.

(It may be worthy of remark, in addition to what has been said in the foregoing pages, that Politzer's method is particularly applicable in those cases of sub-acute catarrh of middle ear, occurring in young persons, which are so frequent in the vicinity of New York. Before the introduction of this method we had like means at our command for the relief of the most annoying symptom—the deafness. In America, at least, the use of the Eustachian catheter will hardly be made available for young persons, as useful and indispensable as it is in the case of adults. I add a few cases taken at random from others, first published in one of our journals,[1] which illustrate the great boon conferred upon the public by this means of treatment.

Case I. Willie S., aged 11, April 28, 1865. Has been growing deaf for some months, is rather delicate. His appetite is extremely capricious, drinks tea and coffee in great excess. He cannot hear ordinary conversation. The left membrana tympani is of a pinkish hue, the right secretes a slight amount of pus, is however intact. The tonsils are somewhat enlarged. Hears an ordinary ticking watch (which should be heard from three to five feet) five inches on the right side, one inch on the left. Politzer's method is practiced two or three times, when the hearing distance was doubled by the watch on the left side, and ordinary conversation was heard with some ease. He was seen every day or two until May 4th, when he returned home, hearing the watch more than two feet on the left side, and six inches on the right, and was not at all perceived to be deaf in conversation. The appropriate constitutional treatment was carried out, only nutritious diet was allowed, an astringent was

[1] American Journal of the Medical Sciences, Vol. LIII. p. 62.

applied to the right drum, and Politzer's method was practiced every two days. This treatment was still carried on at his home by other hands, and the patient was heard from as being still further improved.

CASE II. F. S. B., aged 16, N. Y., September 1, 1865. Has been deaf at times for a number of years, and for the past summer persistently so. His general condition is fair; is well developed. The tonsils were so much hypertrophied as to impede respiration, but they were removed previous to his coming under my observation. The pharynx secretes excessively, as well as the nasal mucous membrane. There are numerous granulations scattered over the pharynx. The drums are pinkish, brilliant in appearance. The light spot is elongated. The watch is heard about six inches from each auricle. Politzer's method was practiced three or four times, when the hearing distance extended to sixteen inches on the right side, and ten on the left. A gargle containing iodine and brandy was ordered to be used twice a day; he was also to practice Politzer's method twice a week, in connection with an iodine inhaler. The patient continued to improve, and at the present writing, April 20, 1866, the treatment has been abandoned, the hearing power being nearly if not quite normal. The patient goes to school every day. He was seen by me for some weeks, once a week, while his father, who is a distinguished physician of this city, carried out the treatment at home, which consisted in the use of the gargle, and inflating the middle ear by Politzer's method once in three or four days, with attention to the general health.

CASE III. Edgar S., aged 17, Connecticut, October 20, 1865. Since the patient was four or five years old he has had more or less trouble in hearing. A few years ago the ears discharged and pained at intervals. The general health is fair; he is tall, well developed, except that he is pigeon breasted. Hearing distance with watch, right ear, one inch; left, two inches. The right drum is sunken, and is quite white in color; no light spot exists. The left drum is intensely reddened and sunken; the centre seems to be united to the wall of the cavity of the tympanum. After the use of Politzer's method in combination with a bulb containing a sponge saturated with tincture of iodine,[1] a few times, the hearing distance on the left

[1] American Journal of Medical Sciences, January, 1866, p. 108.

side was increased to eight inches, but it remained the same on the right. He also heard and pronounced after the speaker, words spoken eighteen feet off, while a few moments before he could only hear them six feet. A Politzer's apparatus was ordered to be used at home, under the direction of his father, twice a week for a month, a slight counter irritation to be kept up over the mastoid process, when he was to report himself. November 26 the patient again presented himself, having carried out the treatment as directed, and can now hear the watch on the right side three inches, on the left twenty inches and more. He hears conversation with ease. Patient was directed to desist from treatment. In 1868 his hearing remained good.

CASE IV. Michael W., aged 13, at Eye and Ear infirmary, November 2, 1865, a delicate bright-looking boy. Whenever he has a cold (as his father says) "it falls to his ears and he gets deaf." Right membrana tympani pink and sunken; left sunken, but of about normal color. Tonsils have been ulcerated: pharynx secreting excessively. Hearing distance, right ear four inches; left, three inches. He was seen twice a week until January 17, 1866, iodized air being used by Politzer's method at each visit; cod-liver oil and ferri iodidi syrup were administered. He had occasional partial relapses, but was at the above date discharged cured. His hearing improved at the first use of the method very markedly.

FIG. 27.

Politzer's Air Bag with inhaler attachment.

CASE V. Girl aged 16, at ear and eye clinic in University Medical College, March 28, 1866. Has not heard ordinary conversation for years, and has been very much embarrassed in swallowing and breathing on account of enlarged tonsils; general condition is fair; the voice is extremely nasal; only hears when addressed in a loud tone of voice; the watch is heard two inches on the right side, one

inch on the left; membrana tympani present nothing striking in appearance, except that they are quite brilliant; the tonsils are excessively hypertrophied. The use of Politzer's method immediately improved the hearing somewhat, which improvement lasted, according to the patient's statement, about a day. When next seen the tonsils were exercised with the forceps and scissors, a long outgrowth being dragged down from behind the soft palate on the right side, which must have pressed upon the orifice of the Eustachian tube, and then the iodized air was driven into the tube. The hearing distance became two feet on the right side, and about six inches on the left. An iodine gargle was ordered, with cod-liver oil, a half tablespoonful to be taken three times a day. The patient is now under treatment, and still, April 26, 1866, continues to improve, hearing very well, with no trouble in respiration. This patient fully recovered.

The bulb figure on the preceding page contains a moist sponge, on which are placed a few drops of tincture of iodine. The combined apparatus is then used in the same manner as the ordinary air bag which constitutes Politzer's apparatus. St. J. R.)

LECTURE XVI.

METHOD OF EXAMINING THE ACUTENESS OF HEARING.

The power of hearing the tick of a watch and understanding conversation, as compared with each other; watching the mouth of the speaker, by a person with impaired hearing; how a measurer of the degree of acuteness of hearing should be constructed; better hearing in the midst of sounds; excessive acuteness of hearing; conduction of sounds through the bones of the head; testing the reflection of sounds.

GENTLEMEN: Since we are now to pass on to the consideration of the diseases that most frequently cause functional anomalies of the sense of hearing, this may be the most appropriate place in which to speak of the different varieties of disturbances of audition, and, at the same time, of the different methods by which we ascertain the hearing power, or acuteness of hearing, of a patient.

When we are dealing with that most common result of an affection of the ear, diminution of the hearing power, we must, in order to ascertain its degree, carefully regard two things which do not always stand in exact proportion to each other: first, how much the patient is prevented from hearing ordinary conversation; second, how far he can hear the sound of certain tone-giving, or vibrating instruments.

We generally use a watch for the examination of the hearing power, ascertaining whether the patient can hear the ticking at any distance from the ear, or only when it

is pressed close upon the auricle or bones. In the former case the watch should be constantly held in the same direction from the ear, for instance, parallel with the auricle; and instead of gradually removing the watch, you should cause it to gradually approach the organ. Thus you will best guard yourself against self-deception on the part of the patient. You will also learn at what distance the patient first begins to appreciate the tick of the watch, and the one where he can distinctly count the ticks. Some aural surgeons hold a measure of leather between the ear and the watch during this examination; consequently a conduction of the sound occurs by means of the fixed body, and the result is quite different from that obtained when the air is the only conductor.

We should previously make an examination of healthy persons with the same watch that we are using with the deaf, in order to correctly determine the normal distance at which it can be heard. A watch with a clear tone should be chosen, if possible. Some watches have no tone at all, but only a smooth rubbing sound, and are therefore very poorly adapted for our purposes. For certain high grades of deafness we can only use repeating or striking watches. These have the advantage that you can approach them to the ear, at one moment when they are striking, at another when they are not doing so; and thus we may be certain as to the exact truth of the patient's statement.

Children and deaf-mutes sometimes state that they hear the watch, both when the repeater has been touched and when it has not. There are also cases where the patient is not able to distinguish the ticking of the watch from the tinnitus aurium, and he thus gives very confusing answers as to the distance at which the watch is heard.

Sometimes it is not unimportant to know that most

watches have a clearer tone immediately after they have been wound, and, on the other hand, that the tone is somewhat softer just after they have been cleaned by a watchmaker.

However, setting aside all these possible means of arriving at false conclusions, the watch alone does not afford a sufficient means of determining the amount of hearing of the person examined, because the distance at which it can be heard does not always stand in proper proportion to the power of understanding conversation. You will quite often find a case where the patient is able to hear conversation of a low tone, quite a considerable distance, and yet can only hear the watch when pressed on the ear; and then, again, you will find the state of things reversed, that is, he understands conversation with great difficulty, while the watch can be heard when it is held some distance from the ear. Such a misproportion, we find, sometimes takes place when other circumstances which may render a correct judgment difficult, such as a peculiar mode of speech, foreign dialect, and want of intelligence, are entirely wanting.

As a general thing, persons who have become hard of hearing in childhood, hear the watch better than conversation; and, on the other hand, those whose deafness has begun later in life, are less prevented from hearing conversation than from hearing the watch.

There are, however, not unfrequently, exceptions to this rule, and some that are very striking. Thus, I saw a sad case, where an extremely intelligent man, a little more than forty years of age, who had become deaf only a short time before, was so to such a degree that he could not hear conversation, even through a speaking tube. He was also extremely short-sighted, an added misfortune, since all communication with him must be by writing. He could hear a repeating watch, however, very well, when laid upon the auricle of one ear, and one inch from the other. (I have seen persons who were

not at all troubled in hearing ordinary conversation, and who were not aware that their hearing was impaired, who could hear an ordinary ticking watch only at a short distance, much less than that at which it was heard by many patients who come under treatment on account of loss of hearing. St. J. R.)

We may explain some cases of this kind by remembering that an adult is more accustomed to understanding conversation than the child, and that therefore it is easier for him. Yet, at other times, this explanation is not sufficient, and you will often find that a patient hears his own voice and that of the surgeon, immediately after the introduction of the catheter, much more distinctly, while he cannot hear the watch any further, and possibly less. Strange as this may seem, I have observed it in many cases, occurring in undoubtedly trustworthy patients, and I have satisfied myself, by various experiments, of the truth of their statements. The cases which verified these observations were those of young persons between the ages of seventeen and twenty, and where there were decided adhesive processes on the membrana tympani. After the artificial membrana tympani has been applied, it is not a rare occurrence that the patient hears conversation markedly better, while the watch is not heard so well as before.

You see, then, gentlemen, what a one-sided opinion you will give as to the hearing of your patient, and as to the benefit of treatment if you rely upon the watch alone as a test of hearing. You must then make a closer examination, by testing the power of hearing the voice and conversation. While one ear is being examined as to this, the other should be closed by the finger of the patient, and you should speak slowly and distinctly, at first in a whisper; for instance, count, towards the side of the patient, varying from a loud to a soft tone, at different distances, or, if necessary, talk through a speaking tube, and

cause the patient to repeat word for word, after you, what is said. You must guard against any deception, by seeing that the patient does not practice the habit of watching the mouth of the speaker. Almost all patients who are hard of hearing, if they are not also myopic, very soon accustom themselves to watching the mouth of the speaker, looking always directly at it, in order to improve their understanding of what is half heard by seeing the motion of the lips. Most patients acquire the habit unconsciously, and, without knowing the reason why, attempt to get opposite the speaker, and look at his face.

Thus, you will often be informed by a patient, as something very peculiar, and as an undoubted proof of nervous deafness, that he hears much worse by twilight and at night in bed, than when it is light about him. This is only a natural result of the fact, that such patients do not have the benefit of sight to aid their hearing.

Women, especially, accustom themselves to this habit of watching the mouth, and, added to it, are such adepts in guessing, that although entirely deaf, they can hold a conversation for hours with their neighbor in society, without being disturbed on account of not hearing. Proper names and bearded men are an abomination to these ladies, for it is through them that their often carefully concealed infirmity comes to light.

If, then, in many deaf persons, the power of hearing the tick of a watch, and understanding conversation, stand in such an evident misproportion to each other, there are various explanations for it which, perhaps, for the greater part, rest on varied acoustic principles. This is not the place to go very extensively into the subject; I will only further remark, that there is a great difference between *hearing* conversation and *understanding* it. A great many patients will tell you that they are aware of the carrying on of a conversation, at a considerable distance

from them, but it is only at a much shorter distance that they are able to tell what is said.

Besides, the tick of a watch has only one tone, or at the most two tones of a certain hight, while it often seems to occur exactly in the case of deaf persons, that some tones, or some classes of tone, which correspond to a certain tone hight, or number of vibrations, are entirely out of reach of the hearing, or can only be appreciated in a considerable increase in the strength of the sound. Thus, there are patients who hear deep tones proportionably better than high ones. Generally, however, the reverse is true, and tones which correspond to an excessive number of vibrations in a given time, as, for example, the voices of females and children, are proportionately better heard, even when the tones are not very strong. The latter is, however, generally the rule. Deep tones must be proportionately stronger in order to be heard equally well with high ones. As is well known, the voice of a basso must have a greater intensity—be stronger than that of the tenor, if he wishes to fill the opera house as well.

In hearing, moreover, it is not only a matter of intensity of the tone, and the number of vibrations in the second, but of the speediness of the tones in following each other, and the space between the individual tones. A measure of the hearing, which shall answer all indications, and possess any practical value, must carry all these various points into view, and must also be conveniently and easily used.

Try, gentlemen, if you, with the aid of a mechanic, at once educated in physics and music, may not be able to construct such an instrument. The acoustic apparatus now to be found in physiological cabinets, such as the *Sirene*, do not answer our purpose, at least so far as I have been in a position to test them. Perhaps such an instrument can be constructed after the manner of a music box,

or hand organ; since in these there are a number of notes in a cylinder, of the same hight of tone, which, by means of a simple contrivance, can be made to move with varied swiftness, and in various degrees of vibration.

Yet we need not continue this subject at too great a length. As insufficient as the watch is, we have as yet no better measurer of hearing, but we should never forget that we must always examine as to the power of hearing conversation. When a repeating watch is not enough to show us if there is still hearing power, we may use a hand bell, ringing it behind the head of the patient.

Von Conta[1] recommends, instead of measuring the distance at which a watch is heard, that a tuning fork, immediately after it has been caused to vibrate, should be placed at the end of a diagnostic tube (Toynbee's otoscope), which has previously been placed in the ear, and the number of seconds counted during which its vibrations may be heard.

Deaf persons very often tell you of hearing better in the midst of noise and roaring sounds. Misapprehension, and lack of proper observation, are generally at the basis of these statements. When a noise takes place about us, we unconsciously raise our voices, so that the patient, who is less disturbed by it than we, has the benefit of this elevation of voice for his less susceptible ear. Many patients say they hear much better when riding in the cars, and the explanation of it must must be the one given above. Besides this, the narrowness of the room, and the closeness of the speakers to each other, should be considered.

Some persons, who at other times hear very well, have great difficulty in understanding what is said while riding in a wagon, so that a deaf person, who is accustomed to

[1] Archiv für Ohrenheilkunde, 1, s. 207.

hearing with difficulty, and with close attention, has then some advantage. I have never heard of any patient, however, who could hear a watch at a great distance under these circumstances.

Yet, there are a number of observations on this subject which cannot be so summarily dismissed. Thus, *Willis* (in 1680), tells of a man who could only converse with his deaf wife while a servant was beating a drum. This rare symptom received the name *paracusis Willisianæ*. *Fielitz* also[1] speaks of a boy, the son of a shoemaker, who could only hear the words spoken in the room when he stood near his father, who pounded sole leather on the lap-stone. Whenever the father wished to speak to him, he took the hammer and pounded the leather. The boy also heard very well in the midst of the sound of a mill, but outside of it he could not.

These are, however, rare instances, and we may ask ourselves if similar symptoms may not arise when there is a partial separation of the connection between the ossicula auditus, in the cavity of the tympanum, for instance, of the stapes from the incus. Loud sounds, such as have been just mentioned, would force the membrana tympani inward, and thus approximate a union of the severed connection of these two bones. If such a case occurs to you, it would be well to try the effect of the celebrated wad of cotton.

Excessive acuteness of hearing.—When we speak of a morbid acuteness, or fineness of hearing, we mean an abnormal sensitiveness of the ear to all sharp, shrill tones and loud noises. This is present in certain irritated conditions of the brain, in the various acute and chronic inflammatory affections of the deeper parts of the ear, and also when a sudden change from hardness of hearing of a

[1] A. G. Richter's Chirurg. Bibliothek. B. ix, st. 3. s. 555.

high grade, to normal hearing power occurs, as, for example, after removing inspissated cerumen from the ear, which has been in the meatus, and impaired the hearing for years.

Conduction of sound through the bones of the head.—By this we understand that sort of conduction of sound to the organs of hearing, which occurs when we bring fixed sonorous bodies immediately in contact with the head. Some writers on aural surgery proceeded from the incorrect idea that the bones alone took part in such a conduction of tones, and that the whole of the remaining sound conducting apparatus of the ear—the auditory canal, membrana tympani, and cavity of the tympanum, with all its contents—was excluded, especially if the meatus were stopped up. They considered themselves to be justified in deciding, from the existence or non-existence of the power of hearing a watch laid upon the bones of the head, whether the auditory nerve, with its expansion into the labyrinth, were in a normal or diseased condition.

The premises are incorrect, and consequently the conclusions. They are detailed by some writers at great length. The view above given depends upon a misapprehension, and one-sided estimation of what was said by *E. H. Weber* and *J. Müller* on this subject. The latter named author very clearly stated,[1] that we are not able to decide how great the conductive power of the bones of the head alone, for sonorous waves, which are communicated to them from the air, or from fixed bodies, may be, because the increase in the conducting power from other sources, and the resonance of the parts belonging to the ear alone, can not be excluded.

If a vibrating body be brought in contact with the bones of the head, vibrations are, of course, conducted

[1] Handbuch der Physiologie, II Bd., 1840, s. 455.

immediately from the fixed parts to the labyrinth; first to the *lamina spiralis ossea* of the cochlea, as being the part of the nervous labyrinth which stands in immediate connection with the bones. Another part of the vibrations, however, which are conducted to the labyrinth, are those which are first brought upon the membrana tympani and the ossicula auditus.[1]

E. H. Weber first enunciated the idea (1834) that the membrana tympani and ossicula must also vibrate in the conduction of sound through the bones of the head. The experimental proof was furnished very recently by *A. Lucae*.

It is only recently that aural surgeons, *A. Lucae* and *Politzer*, have made the conduction of sounds through the bones the object of a strictly scientific investigation.[1] The latter, especially, attempted to render the subject a practical one, in the diagnosis and prognosis of aural disease.

We cannot here go into a consideration of all the questions arising on this point, since many of them are not yet fully settled, and the complication of the experiments causes some of the results to seemingly contradict each other.

For the purpose of testing the perception of sound through the bones, we should use a watch having a loud tick, as well as a strong toned tuning fork. It will be better to employ several of the latter, of different tones. For the purpose of testing with the watch, it is laid on the temples and the mastoid process, while the patient gently closes each auditory meatus. If the tick cannot be heard on either side, the watch is taken between the teeth.

1 *Lucae*, Virchow's Archiv., B. xxv and xxix. Mediz, Central Blatt, 1863, Nos. 40, 41: 1865, No. 13. Archiv für Ohrenhelkunde, 14. *Politzer*, A. F. O., 1 and 4. *Mach*, Wiener Akad, Sitzungs Bericht, 1863, '64, '65.

After the tuning fork is set in vibration, by striking it, its handle is placed on the median line of the vertex of the head, and the patient is asked in which ear he hears better. If the answer be undecided, the handle of the vibrating tuning fork is placed at the center of the upper row of teeth.

The fact which has been for a long time well known, that the tone of a watch or tuning fork held on the bones of the head or on the teeth, is immediately heard better if the auditory canals are closed without any pressure, should be considered as the point from which all conclusions must come as to the practical value of the conduction of sound through the bones of the head (*Knochenleitung*).

Very different explanations have been given to the facts already observed by *E. H. Weber*. The most valuable and practical are those of *Mach* (referred to in the note on the preceding page). According to this author, the tones are increased in strength, because the sonorous waves are prevented from being softened or dissipated by passing out of the ear.

(We must accept the view, that when the sound passes from the air through the membrana tympani and ossicula to the labyrinth, that it must again pass out, in part at least, by the same way.)

The same effect that is produced in a physiological experiment by stopping up the meatus with the finger, is caused in a patient with aural disease, by any abnormity in the sound conducting apparatus. Just as any hindrance to the conduction of sound makes the entrance of tones into the ear difficult, so does it prevent the breaking up or dissipation of the sonorous waves, if they are carried to the ear, by the bones of the head. They must then be carried to the expansion of the auditory nerve in the labyrinth in double strength, as long as this part possesses a normal power of receiving sounds.

Those vibrations, especially, that are carried by the bones of the head upon the membrana tympani, and ossicula, must be prevented—if certain anomalies of tension and mobility of these parts exist—from being reflected outward, and must therefore be conducted with double power inward, through the fenestra to the labyrinth.

Patients with stoppage of the meatus (by cerumen, a foreign body, furuncular inflammation), alterations in the tension and thickness of the membrana tympani (from closure of the tube, myringitis), or in whose middle ear the air encounters resistances (e. g., by a collection of mucus or pus in the ossicula, by their rigidity, or by relaxation or thickening of the membranes of the fenestrae), if the affection be in one ear only, or of different degrees in the two ears, and there is no abnormal condition of the labyrinth, are able to hear a tuning fork placed on the median line of the vertex of the head, better in the affected ear than in the other. If this state of things does not exist, or if the patient hears the tuning fork better in the normal or least affected ear, we may conclude with some probability, that there is a lessened perceptive power in the expansion of the auditory nerve in the labyrinth. A further observation and analysis of the case will then decide whether we should consider this abnormal condition in the internal ear as a primary or

to the diagnosis, but also the prognosis in individual cases, may be obtained from the estimation of the degree of the perception of sounds through the bones of the head. These should be taken advantage of in chronic catarrh of the middle ear, wherever the worse ear does not hear better when the watch is placed on the bones, for this is a disease exceedingly varied in its symptoms, and in which it is exceedingly difficult to make a prognosis. *Politzer* very properly calls our attention to the fact that this symptom should never be viewed by itself, but in connection with others, especially with the course and duration of the disease, as well as the kind of tinnitus aurium which may exist.

One of the objections to this mode of examination is, that we must be contented in using it, with the evidence, and the talent for observation which the patient may be able to give and which he happens to possess. This latter is sometimes surprisingly small. Some patients cannot tell that they hear on one side better than the other, even if it be so. It is, therefore, very often necessary to urge the patient to make an unprejudiced investigation, and to explain the method to him, and at least, to repeat the experiments several times.

Politzer says, in a letter to me, that in cases where the patient is not able to state at all correctly in which ear he hears the tuning fork better, he places both ends of a single otoscope (or diagnostic tube) in the auditory canals, and that then the sensation is more decided.

For the objective examination as to the degree of the passage of the sound from one or the other ear, Politzer recommends an otoscope (or diagnostic tube), of two feet in length, which is placed in both auditory canals. From the center of this passes a gutta-percha tube of one foot long, communicating with the caliber of the otoscope. *Lucae* used for the same purpose a double otoscope, made like the double stethoscope of *Scott Allison*.

While the tuning fork, which has been placed in vibration, is on the vertex of the head, or on the teeth of the patient, we may by alternately pressing the two arms passing to the patient's ear, determine from which ear the tone is coming, and also distinguish the difference in its magnitude and clearness. Care should be taken that the tuning fork is vibrating fully, and that the two ends of the three armed tube are evenly placed in the meatus. Politzer calls attention to the fact that even in those who hear normally, differences in the strength of tone with which a tuning fork placed on the bones of the head is heard, may be at times perceived. These may depend upon an unequal width of the auditory canal. The same author shows that the results of this method of examination have, up to the present time, not been entirely satisfactory.

I should still say to you that *Lucae* lays a great weight upon the fact of the better hearing power of a patient, if it so happen that he does hear better, when the watch or tuning fork is placed on the bones, while the auditory meatus is closed. He says that in the cases where no improvement occurs we must conclude that there is some impediment that prevents the membrana tympani from becoming tense in an inward direction, and the stapes from exerting pressure upon the contents of the labyrinth. According to *Lucae* the increase in the strength of the tone, when the auditory meatus is secluded, depends upon the increase in the intra-auricular pressure.

The power of perceiving sounds through the bones is much less in advanced age than earlier in life. We can therefore draw no direct conclusions from a want of hearing the watch or tuning fork after a patient is over fifty years of age.

Lucae has recently described a new method of examining the organ of hearing for physiological and diagnostic purposes, with the aid of the "interference otoscope."

By this name he designates the double otoscope described above, but altered in such a manner that an india-rubber tube is inserted in it, which leads to a small metal sound receiver, of the shape of a half paraboloid. The latter is brought in front of a tuning fork placed on an isolated stand, and this is struck by means of a small wooden hammer. By alternately pressing together one and the other tube of the double otoscope we may decide how much the sonorous waves are reflected from each ear. This reflection of sounds increases in all changes in the sound-conducting apparatus, which either directly or indirectly cause an increased tension of the membrana tympani.

By this objective examination of the reflective power of the ear we may gain assistance for determining how far anomalies of the sound-conducting apparatus, not recognizable with the catheter and ear mirror, may cause the impairment of hearing, or we may determine if disease of the labyrinth exists, in which latter case no great reflection of the sonorous waves conducted into the meatus will occur.

LECTURE XVII.

SIMPLE ACUTE AURAL CATARRH

Different forms of catarrh of the middle ear; acute catarrh, its symptoms and consequences; treatment.

GENTLEMEN: We come to-day to the diseases of the middle ear, and first to the inflammations of its mucous membrane. Catarrh of the middle ear may be designated as either simple or purulent, and each of these varieties may have an acute or a chronic form.

An inflammation of the periosteum of the middle ear, spoken of by several authors as an independent and primary affection, hardly occurs, any more than a periostitis of the external auditory canal, of which we have previously spoken. It is anatomically impossible to divide the lining of the middle ear into mucous membrane and periosteum. How, then, can we distinguish different affections of this membrane? Here, still more than in the bony part of the external auditory canal, each intensive inflammation of the integument must bring with it disturbance of the nutrition of the bone lying beneath, for the membrane which we are accustomed to call mucous is at the same time the carrier of the vessels for the bone; it is also periosteum as well as mucous membrane. Every inflammation of the mucous membrane lining the cavity of the tympanum and the mastoid process, is also an inflammation of the periosteum; every catarrh of this membrane is a peri-

titis. If the inflammation be chronic in its course, hickening of the mucous membrane and hypertrophy of he bone, hyperostosis, more easily occurs; while in acute processes, as is well known, the mucous membrane inclines more to ulceration, and periostitis leads to atrophy of the bone, inflammatory softening, and superficial caries. I have often seen diseases of the bones of the middle ear as the result of very acute, or long existing inflammation of its soft parts. On the other hand I have observed no disease that seemed to certainly indicate an independent and primary periostitis.

Acute catarrh of the ear.—We may employ this expression for the sake of brevity, since the middle ear is the only part of the organ covered by mucous membrane, and consequently the only one affected with catarrh. It is characterized by hyperæmic swelling of the whole mucous tract of the middle ear, with great increase of secretion, which has chiefly a mucous character. It is a much more rare form of disease than the chronic variety.

I have hitherto observed these cases mostly in the early spring, or late in the fall. They generally occur from some definite cause, for instance, after "catching cold," from getting the body very wet, and generally in connection with catarrhal inflammations of the nasal passages or fauces, or with bronchial catarrh or inflammation of the lungs. The lower portion of the Eustachian tube is involved in nearly every severe cold in the head, or naso-pharyngeal catarrh. From such a mild and generally temporary form of circumscribed acute aural catarrh, or, if you please, tubal catarrh, in persons especially predisposed, or from some new exciting cause, an extensive and severe form of the affection may arise. It may be said, in general, that persons inclined to inflammations of mucous membranes are very apt to have inflam-

mations of the middle ear. We therefore often find the acute form arising in many cases, when the patients have been suffering for a long time from the chronic form. Most of the cases that I have observed have been those where the patient has suffered for a long time from deafness of one side, in consequence of chronic catarrh, and the interval hearing ear was then attacked with the acute disease. A person who, to all appearances, had heard well, certainly well enough for all his ordinary duties, suddenly became, as it were, limited to hearing only the loudest sounds. I have observed these cases especially often among men in middle life. They often result from the extension of a secondary syphilitic eruption of the mucous membrane of the pharynx and tongue. In such cases the aural catarrh usually affects one side only, but on close examination you will scarcely ever find the other ear entirely free from disease.

The impairment of hearing is generally of a high degree. Not rarely it is nearly absolute as regards common conversation. The loss of hearing generally occurs quite suddenly, and is consequently the more marked, and yet the patient will often remember that some time before the sudden seizure he had noticed a slight temporary diminution of his sharpness of hearing. With the deafness the patient sometimes experiences nothing more than a feeling of pressure and fullness in the ear. Much more

of the head. In one case every swallow of cold water caused so much pain that water and other fluids were warmed before they could be used. This pain is often accompanied by toothache, and it must be here stated that pain in the molar teeth is often hard to distinguish from pain in the middle ear. In severe cases the pain will be referred to the mastoid process, and this will be found sensitive to any considerable pressure, even when no external evidences of disease can be discerned. The pain generally runs over the whole side of the head, being more severe in the front part, in the region of the frontal sinus. Noises in the ear are scarcely ever wanting. They form part of the greatest trouble of the patient, on account of the great hammering and pounding going on there. One patient said it seemed to him as if an empty barrel were struck upon close to his head. The patients are much disturbed by these sounds, and are often in doubt if they are not real ones that are being made near them.

Add to all this, that such patients have an intense heaviness in the head; that they not unfrequently suffer from vertigo, even when they lie quietly in bed; that febrile symptoms of variable degree scarcely ever fail, which increase in the evening almost to delirium, and you will more easily understand how it is that those persons, who a few days before were not disturbed in the least in understanding all that was said, and not at all hindered in their daily occupation, now bear in their faces the picture of the most intense anxiety, as with wide-open eyes they listen for each word which has no sound for them, and look around in great loathing and disquiet to see whence comes this constant noise, reduced and excited as they are by fever, pain, anxiety and loss of sleep.

You will understand, I say, how the patients give you the impression that they are suffering from cerebral or mental disease. You need not be surprised that acute

catarrh of the ear is sometimes called meningitis, or acute congestion of the brain, especially when the pain in the ear has become so extended as no longer to be locally distinguished, or when the deafness on the one side escapes notice, and thus the attention of the surgeon is in no respect turned to the ear.

I can assure you that many persons have come to me with "nervous deafness" induced by an inflammation of the brain, according to the statement of their physicians, when an examination of the ear showed that the impaired hearing was in consequence of acute catarrh of the cavity of the tympanum.

It is especially difficult, in the case of children, to distinguish acute aural catarrh from a congested condition of the brain. It seems probable to me, from some anatomical facts, which I shall lay before you in the course of these lectures, that purulent catarrh occurs very often in children, and that its symptoms are very often misunderstood.

You remember, from our anatomical studies, the connection existing between the vessels of the cavity of the tympanum and of the dura mater, formed by means of a branch of the arteria meningea media passing through the petro-squamosal fissure. Every peculiar attack of vertigo and irritation of the membranes of the brain, so frequently observed in inflammation of the cavity of the tympanum, especially in acute catarrh, may depend in part at least on this anatomical condition. It is also possible that some of these symptoms may be indications of consecutive hyperæmia of the labyrinth.

It is more probable, however, that they are due to increased intra-auricular pressure, from the pressure upon the fenestræ, dependent either upon congestive swelling of the membrane, or upon secretion collected in the cavity of the tympanum.

If we examine the ear during an attack of acute catarrh,

we find the external auditory canal wholly unaltered, if we except an increased redness close to the membrana tympani. In trivial cases this only appears as a light tinge of red mingled with the grey color of the membrane. This depends upon the injection of the mucous membrane, and of the whole structure of the cavity of the tympanum, which has an influence upon the color of the thin and transparent membrane. In the most hyperæmic stages the membrana tympani usually appears very brilliant. This brilliancy causes the very red transparent membrane to look like a polished copper plate. (*Politzer.*) Soon, and sometimes immediately, the brilliancy of the outer surface is lessened, or even removed. It ceases to reflect the light evenly in some portions in consequence of its infiltration, and thus the triangular light spot, which we are accustomed to see on the membrana tympani, at the anterior and lower portion, can no longer be discerned, or is seen very indistinctly. The handle of the malleus, in all cases where the outer surface of the membrane is not much affected, remains plainly visible, and this is a point which helps us in our diagnosis, for in such a case, the situation of the affection must be deeper than the surface of the membrana tympani. In severe cases, however, in consequence of the greater infiltration of the epidermis and cutis, we can no longer see the handle of the malleus. The vessels running over it are seen filled with blood, so that we have a red line in the middle of the membrane, running from above downward. The surface of the drum appears dull, of a bluish grey color. Sometimes minute vessels are seen in the periphery of the membrane. In some places the curvature or plane of the membrane is altered, either in consequence of the increased secretion pushing it forward, or of different degrees of swelling of the various parts.

The discoloration of the membrana tympani frequently

varies in the different parts of the membrane; for example, it may be of a reddish grey color in the upper part, while in the lower half it is greyish yellow or yellowish white.

The appearance of the parts varies, of course, in accordance with the severity of the attack, and with the amount of the changes in the mucous membrane and the membrana tympani, that have previously existed. Thus, the hyperaemia of the cavity of the tympanum, and of the inner surface of the membrana tympani, will not appear where the thickening of these membranes has occurred as a result of previous inflammation. In cases where a long continued chronic catarrh suddenly increases, which may be called sub-acute catarrh of the cavity of the tympanum, all these symptoms will be less prominent, and the disease will resemble an exacerbation of a severe chronic catarrh.

We are not always able to tell in the very first stages of the affection, whether we are dealing with an acute catarrh of the cavity of the tympanum, or an acute inflammation of the membrana tympani, i. e., myringitis. The impairment of hearing is generally much greater in the former variety of disease, and it is generally improved, or the other symptoms relieved, by the forcing in of air. Besides, in acute aural catarrh there are usually catarrhal symptoms in the naso-pharyngeal space.

If we examine the ear in the later stages of the affection, the membrana tympani does not appear to have lost so much of its brilliancy; the triangular light spot is changed, generally lessened in size, however. It is at times only a point. It is very rarely diffused over the whole surface without any distinct borders. The membrane is usually somewhat opaque, of a dull lead color, and occasionally it has a moist look, and here and there, perhaps, a white or yellow appearance is mingled with the dull grey color. It will only be found to be injected along the handle of

the malleus, which is distinct, although often very much drawn inward. It is abnormally concave as a whole, and—apart from some partial irregularities in its curvature—there is often seen a band running backwards and downwards from the short process of the malleus, which may account for the abnormal concavity.

I have never seen any considerable redness or swelling of the external parts in the vicinity of the ear during the affection; at the most they are somewhat tender on pressure. We find, however, that the throat participates in the attack, there being always a severe injection of the mucous membrane of the pharynx. There is generally pain and difficulty in swallowing, stuffing of the nasal meatus, dryness of the mouth, and other catarrhal symptoms. Many patients complain of crackling sounds towards the ear at every motion of swallowing, accompanied by variations in hearing and in the feeling of the ear. Such patients nearly always complain of a hollow sound of their own voice, which symptom is particularly marked on closing the unaffected ear. After the pain and the febrile symptoms have disappeared, the heavy feeling in the ear and in the head, and deafness, still remain for some time. The crackling and whistling sound in the ear occurs more frequently, and the patient always has the hope that some time, sooner or later, the loud report, so famous for being the prelude to restoration to hearing, will occur, and that he will then be well again. It is really true that we may occasionally observe a case where a patient hears a loud report in his ear during sneezing or yawning, and that the hearing is greatly improved after it. Sometimes the hearing is gradually improved without any such report. In many other cases, however, in spite of general treatment, it remains for months and years the same, until at last the catheter is introduced. Morbid changes on the membranes of the fenestræ not unfrequently occur from such

an acute catarrh, which we are not able to lessen unless the patient comes under treatment at an early stage, and thus an incurable obtuseness of hearing may remain.

Prognosis. — In acute catarrh of the cavity of the tympanum without suppuration, the prognosis is, to a certain extent, favorable. It is certainly only with an entirely inappropriate treatment that a deeper seated affection occurs. The slight impairment of hearing, which is all that usually results, may be generally improved by an early local treatment. The reason that perforation of the membrana tympani is comparatively rare in this affection, is, that there is more tendency to thickening and swelling than softening and deliquescence of tissue. Perforation may occur, however, if poultices are used very much in the treatment.

Just at the beginning of a very severe case, where exudation follows very rapidly, or after blowing the nostrils, or a severe fit of sneezing, a small rupture of the membrana tympani sometimes occurs, with a slight amount of bloody serous discharge. As a rule, the edges of this perforation unite very quickly, so that on the next day the rent is usually closed, and the further course of the affection is not different from a simple acute catarrh.

There is, however, a somewhat unfavorable view in the prognosis arising from the fact that relapses often occur. Still more frequently there remains an unmistakable tendency to continuous chronic catarrh of the ear. We may very often observe cases where persons who have once suffered from an acute catarrh of the ear, and who again acquired a good hearing power, after it had subsided, become deafer and deafer as years pass on, without any sudden change in the hearing at any one time, or without acute inflammatory symptoms of any sort. In some cases this state of things occurs in sub-acute stages. Very many patients whose hearing is impaired will recol-

lect such acute attacks, that made them perfectly deaf for a time, as having occurred in early life. They recovered their hearing, to a certain extent, through constitutional treatment, without any local treatment whatever. In the course of time such patients may, very gradually, become very hard of hearing.

These facts may be explained in a two-fold manner. On the one hand, as experience tells us, every person who has suffered once from a severe catarrh of any organ, remains for a long time especially predisposed to an affection of the same part. There is, on the other hand, an anatomical reason for the explanation of such cases. Among the most frequent consequences of such an acute catarrh of the ear, are permanent thickening of the mucous membrane lining the middle ear, as well as various forms of adhesions and attachments which are developed from the contact of the two surfaces which existed at the time of the acute inflammation. These adhesions most frequently connect those parts of the middle ear which are the least distance apart in a normal condition of things. Such connections occur most commonly between the membrana tympani and promontory, between the same membrane and the incus, or the membrana tympani and the head of the stapes, and still more often between the two niches of the fenestra ovalis and rotunda; in one place connecting the walls of the cavity with each other, in another with the stapes.

It is clear that when such adhesions have taken place, and the space of the cavity is so much diminished, each swelling of the mucous membrane, such as occurs with every cold in the head, is at least of some importance. Each congestion of the membrane, however slight, which could produce no effect upon a normal cavity, in one that has been narrowed as above described, will diminish the sharpness of hearing in a sensible degree. In the same

way, the parts already abnormally approximated are brought still nearer, until every angle and space is filled.

Furthermore, every thickening of the membrane of the tube, and anomaly in its secretion, are of especial importance, because they greatly favor the occurrence of subsequent closure of the tube. If in consequence of such acute inflammation of the glandular layer of the tube, an hypertrophy occurs, and the sub-mucous tissue becomes thickened, while at the same time the glands incline to secrete a tenacious thick mucus, the power required of the muscle to open the tube is increased. These muscles finally become unable to overcome the constantly increasing resistance. Thus the regularity in the opening of the tube necessary to insure a normal condition of the ear is very easily and frequently impaired.

It is also to be conceived that such abnormal attachment and adhesions, even if of themselves they do not impair the hearing a great deal, constantly exercise a bad effect upon the parts, by keeping up a state of irritation. Thus, without any further exciting cause, they become the basis of a constantly occurring condition of local congestion. As is well known, such a state of things occurs in the eye, when adhesions have occurred between the iris and the capsule of the lens, in so-called posterior synechia.

When such adhesions exist in the eye, irregularity of action and tension occur during the act of accommodation of vision for different distances, and at every movement of the iris, which always lead to relapses and renewed attacks of iritis.

What was once explained as resulting from a "rheumatic diathesis," may now be referred to a purely mechanical cause, since the first inflammation left a permanent source of irritation, from which a constant influence is excited on the iris. There is a similar condition of things in the ear, even if we are not correct in ascribing a certain amount of

accommodating power to the stapedius and tensor tympani muscles. Still their presence and muscular structure give evidence that they are the source of motion to the parts upon which they act. These motions must certainly be irregular, and inharmonious, if the parts to be acted upon are confined by adhesions.

We may assert that a congested condition may be maintained by such synechiæ, in the ear as well as in the eye, and made the basis of repeated attacks of imflammation. As each iritis which leaves behind a synechia, retains a tendency to a return of the inflammation, and to formation of new adhesions, so we must believe that each catarrh of the cavity of the tympanum will more or less affect the ear injuriously at a later period, and that irritation will be more apt to occur in proportion to the number of adhesions left behind.

It follows from the foregoing that the results of treatment will depend upon our ability to prevent permanent thickening of the mucous membrane, and adhesion of its various parts with each other.

Treatment.—We shall best accomplish the results desired, if the catheter be introduced as soon as possible, and air forced through it into the cavity of the tympanum. Following the advice of the authors, I formerly delayed the introduction of the instrument until the acute inflammatory symptoms had disappeared, lest I should excite pain, and do injury to the parts. I have satisfied myself by many experiments, that it is not at all necessary to wait so long, and that we shorten the inflammatory process by introducing the catheter. I have sometimes introduced the instrument at a time when the membrana tympani was greatly injected, and the patient had intense pain in the ear. Instead of an increase of pain from the introduction of air, the patient always found it lessened,

if not at the very moment, at least in a short time after. In short, he began to improve from that time. Not unfrequently the pain ceased after the catheterization, or a very great improvement of the hearing resulted, even when the sensation of the patient, and auscultation and examination of the drum showed that the air did not enter the cavity of the tympanum, but that the tube was simply rendered pervious.

Recall the condition of the ear during the inflammatory process, and you may explain this. The membrane is everywhere swollen, the secretion greatly increased. This secretion fills the cells of the mastoid process as well as the cavity of the tympanum, and it cannot find exit, because the Eustachian tube, which is of the same structure, is affected in the same manner, and its swollen walls prevent the egress. If we reopen this passage by a vigorous blowing in of air, some of the secretion will yield, the pressure will be removed from the walls of the cavity of the tympanum, and especially from the susceptible membrana tympani. It is on this membrane that the chief symptoms of pressure will be felt, and when it is relieved much of the congestion and inflammation will also be removed.

Very recently[1] *Schwartze* recommends paracentesis of the membrana tympani, in the cases of collections of mucus in the cavity of the tympanum so large as to cause a bulging outward of the drum. According to Schwartze's observations this bulging outwards occurs most frequently in childhood. Since the secretion rapidly reaccumulates, the paracentesis should be repeated. No considerable inflammatory reaction is said to follow such a repetition. *Schwartze* considers this treatment as one more certainly adapted to prevent the changes ordinarily arising from acute aural catarrh than the employment of the air bath

[1] Archiv für Ohrenheilkunde, II, IV, s. 264.

through the catheter. Of course when the patient is in a very excitable or febrile condition from constitutional disease, we should not immediately attempt the introduction of the catheter, which may then seem to the patient a formidable operation. In such cases Politzer's method furnishes a very welcome substitute for it. Any great or sudden pressure of air is to be avoided during the acute stages of the disease; we may therefore force in the air through a tube of gutta percha, by means of the mouth, instead of using the india rubber air bag. Any sort of a tube will do, in case of necessity, instead of a rubber one.

We may employ local blood letting in the first stages, whether we are able to use the catheter or not, with a cathartic of calomel and jalap, 2-3 grains of the former, with 5-8 of the latter, in a powder, of which 4 6 may be taken during twenty-four hours. Four to six leeches may be applied, part of them just anterior to, and partly just under, the external meatus. The severe pain will generally cease with this treatment; when it does not the ear may be filled every hour with warm water, which the patient allows to remain in about fifteen minutes. The patient should remain in bed, and gentle diaphoresis be produced (with aq. acetat. amm. in tablespoonful doses). We must look after the catarrhal symptoms of the fauces and nose, and as soon as motions of the throat can be borne, let the part be gargled with an infusion of marsh mallow, to which a little borax is added. A little later on an astringent gargle may be employed. It has been sometimes advised to give an emetic in these cases, especially tartrate of antimony and potash, or an agent that will cause sneezing, in order that by means of the severe shaking of the head, through the vomiting or sneezing, the mucus may find its way more easily through the Eustachian tube. Such a strong impression as is produced by severe sneezing or vomiting, may have a some-

what dangerous effect on the membrana tympani—its rupture might be easily caused. The introduction of the catheter, or the use of Politzer's method, is certainly not accompanied by as much danger, and their effect is more easily regulated. If the acute stages be once passed, the treatment is no different from that of chronic catarrh, of which we shall speak in the next lecture.

(I am obliged to dissent from that part of the treatment of acute aural catarrh, as advised by the author in the foregoing pages, which speaks of the use of calomel and jalap. I regard the use of these powerful agents as wholly unnecessary in this class of cases. I would rely upon the leeching, the use of diaphoretics of various kinds, and gargles, in connection with the practice of filling the ear with warm water. The use of Dr. E. H. Clark's aural douche will be found a convenient and pleasant means of treatment. (See fig. 12, page 95.) If necessary a mild cathartic may be given, but if the attack has not been preceded by constipation, I can see no advantage in the use of active cathartic remedies. It is well known that our treatment of acute disease of the eyes has been much simplified in the past few years by abstaining from the free use of mercury, counter irritation, etc., in the various forms of ophthalmia. My experience seems to teach me that we may in like manner simplify the treatment of acute aural disease with success.

The effect of leeches in acute aural catarrh, in relieving the agonizing pains that usually accompany it, is almost magical. I have seen very many cases that have been treated for days by ear drops, and blisters, with absolute no benefit, until the patients were nearly exhausted with pain, and in which the application of one or two leeches on the tragus has caused relief in a very few minutes. The remedy is somewhat troublesome, but in case the use of the warm douche does not soon relieve the pain,

ɔw of no substitute for leeches. Besides their value to :rcome the acute symptoms, they prevent the unpleasant ısequences that have been so graphically described in : foregoing pages. Turkish and Russian baths are :ommended by Dr. Agnew, of this city, in the acute ıges of aural catarrh. St. J. R.)

LECTURE XVIII.

SIMPLE CHRONIC AURAL CATARRH.

Its varieties; sclerosis; catarrh of the tube, and true catarrh of the middle ear; pathological anatomy; course and subjective symptoms; some peculiar "nervous" symptoms; an attempt to explain them.

GENTLEMEN: We shall consider to-day the chronic form of non-suppurative, or simple aural catarrh. Like all inflammations, chronic catarrh of the mucous membrane of the ear sometimes affects the interior of tissue, that is, it is interstitial, and thus chiefly produces a thickening and loss of elasticity of the tissue.

Again, it is chiefly characterized by hyperæmic swelling, and abnormally increased secretion, with consequent thickening, hypertrophy of the mucous membrane.

We may then divide chronic aural catarrh into two great varieties, and the latter form—true or moist catarrh—into two sub varieties.

The one form affects the Eustachian tube principally, gradually narrowing it, and frequently closing it entirely. The other shows itself chiefly by hyperaemia, and swelling of the membrana of the cavity of the tympanum.

(The three forms, then, may be classified as follows:

1. Sclerosis of the mucous membrane of the middle ear.

2. Catarrh of the Eustachian tube.

3. True catarrh of the cavity of the tympanum. St. J. R.)

Each of these forms may occur independently of each other. More frequently, however, they cannot be accurately distinguished, but are combined with each other. It will be better, therefore, not to speak of each form separately.

Having thus premised that these varieties of the affection exist, we may say in a general way, that chronic aural catarrh consists of a repeated swelling, with gradual thickening of the mucous membrane lining the middle ear, which morbid process generally takes place during a stage of great congestion, and is usually accompanied by increased secretion.

Pathology.—Before we pass on to speak of the symptoms and course of this form of disease, I may attempt to briefly describe the pathological conditions which result from it, so far as we have learned them by investigations on the dead subject. We have, however, not yet reached any satisfactory stage in our knowledge of the pathology of chronic aural catarrh, but we must characterize the condition of things in this department as only initiatory. It is only a short time since it was even attempted to place our knowledge of diseases of the ear on an anatomical basis. Until quite recently the greater number of aural affections that were not suppurative, and all forms of deafness which did not depend on some affection of the external auditory canal, which we now consider as consequences of chronic catarrh of the middle ear, were characterized as "nervous affections of the ear."

In this extremely convenient view, any investigation on an anatomical basis, that is, by an examination of the parts on the cadaver, was of course regarded as superfluous. This having been the state of things, it is not sur-

prising that our knowledge and ideas of the morbid charges in chronic aural catarrh are still in a somewhat crude condition, that they are chiefly confined to what may be observed with the naked eye, and that we do not yet properly understand the finer changes in the tissue of the middle ear. The muco-periosteal lining of the osseous middle ear, which for the sake of brevity we call a mucous membrane has as yet received no complete microscopic examination as to its condition in a state of health.

I would suggest this labor to one of you, as the subject of an inaugural thesis for the degree of doctor of medicine. It is a work whose performance is much to be desired.

We know the least about that form which we describe as an interstitial process, as a dry catarrh (if I may use the term), or as sclerosis of the mucous membrane of the middle ear. These names accord with a practical need of distinguishing certain forms of aural disease which we must refer to morbid processes in the middle ear, from the ordinary form of aural catarrh. It is possible that an extension of our knowledge of this form, founded on an anatomical basis, would give it an independent position in the classification of aural disease.

This sclerosis is a pathological process, in which the mucous membrane becomes denser, more rigid and inelastic. These changes impair the vibratory power of the membrana tympani very much, and of the membranes of the fenestra rotunda, and fenestra ovalis. They finally lead to complete rigidity, calcareous or osseous degeneration of the membrane surrounding the stapes, anchylosis of the stapes, or of the membrane of the fenestra rotunda.

We do not yet know certainly whether calcareous deposits, or other molecular changes constitute the basis of this condition. The alterations may possibly be chiefly periosteal, accompanied by the formation of exostosis, or

perhaps be dependent on shrinkage of a tissue that was previously hyperæmic and relaxed.

We are better informed as to the changes which the true, or moist chronic catarrh of the cavity of the tympanum may produce. In recent cases these changes are hyperæmic swelling, and hypersecretion of the mucous membrane. In old cases the very thin and transparent covering of the middle ear becomes of a whitish or bluish gray color, more or less thickened, and at the same time its surface, as well as the interior of its tissue, are very vascular.

At times there is the same condition of the mucous membrane in all the structures and walls of the cavity of the tympanum. Again, the vascularity is more decided on one part than another. Thus, cases occur where there is only hypertrophy of the mucous fold of the membrana tympani, while in other parts the cavity is in a normal condition. The membrana tympani may, on the other hand, be in a completely healthy condition, and the hypertrophy be confined to the membranes of the fenestræ. The whole of the mucous membrani is, however, more frequently affected.

We may now look a little more in detail at the changes that may occur on the various parts of the cavity of the tympanum. The general thickening of the mucous membrane is very frequently extended to the articulations of the *ossicula auditus*, especially to the articulation of the malleus and incus.

The articular capsule becomes gradually thicker and thicker, and thus the mobility of the articulation is affected. It may at last become fully destroyed, and the joint become anchylosed. Just as often the band by which the head of the malleus is fastened to the roof of the cavity of the tympanum (*lig. suspensorium cap. mallei*) becomes hypertrophied. An abnormal fixation of this

part, and by subsequent shrinkage, an abnormal position of the malleus occurs, which again exert an influence upon the vibratory power of the membrana tympani. The same changes in the tendon of the tensor tympani muscle exert similar influences on the malleus and membrana tympani, stretching their attachments and changing their position. This tendon, while it is attached to the neck of the malleus, has not only a mucous coating of its own, but is extensively connected, especially anteriorly, with the adjacent mucous membrane.

Among the more important parts which may be drawn into participation in such a chronic catarrhal process, the fenestra rotunda and fenestra ovalis should be especially mentioned. We not unfrequently find the small bony canal, or the niche, over whose extremity the membrane of the fenestra rotunda is stretched, covered by a more or less rigid pseudo-membrane, or its mucous membrane is hypertrophied, and thus the canal or niche is narrowed. It may be even completely filled by thickened and vascular mucous membrane, as well as by a plug of connective tissue.

In the same manner the membrane of the fenestra rotunda itself, the so-called *membrana tympani secondaria* becomes thickened. Perfect calcareous degeneration of this membrane may also occur. Similar changes take place in the niche or depression for the stapes, and the membrane surrounding the fenestra ovalis and the base of the stapes. This membrane, like the covering of the fenestra ovalis, has a delicate coating from the mucous membrane of the middle ear.

Sometimes the stapes is fixed in one direction or the other by abnormal ligaments, or even by little osseous connections. Again, it is immovably fixed in a proliferating mucous membrane, or in a mass of rigid connective tissue. In other cases the annular ligament surrounding

the base of the stapes is thickened, or even entirely calcareous. All these conditions must greatly impair the functions of this important terminal extremity of the chain of bones, as well as the conduction of sound to the labyrinth.

The above described alterations in the fenestra ovalis and rotunda, belong in part to the adhesive processes in the cavity of the tympanum, of whose occurrence we have already spoken. Such an abnormal attachment of parts, that were previously disconnected, results not only in consequence of acute catarrh, but it may also be gradually developed in the course of cases of the chronic variety. If thec ongestive swelling be very great, or if the process be attended by suppuration, these attachments may become very extensive. Extensive synechiæ of the membrana tympani are found to be especially frequent, as a consequence of catarrhal affections which have occurred during childhood.

I may here speak of the more or less extensive pseudo-membrane and neoplastic formations developed from swollen mucous membrane, which occur in various parts of the middle ear, for example, between the membrana tympani and the different walls of the cavity; between the tendon of the tensor tympani and the *ossicula auditus;* between the latter and the walls, as well as between the individual bones themselves. Such adhesions fill up the spaces and angles of the cavity, and put one or the other part in an abnormal state of tension. The cavity of the tympanum itself may be obliterated by the development of masses of connective tissue. It may be even divided into separate parts by these partition-like adhesions. In view of the great variety of such conditions as have been just enumerated, it is scarcely worth while to describe them any more exactly, since each post mortem examination may exhibit a new variety.

We may best observe the great variety of these adhe-

sions, by the examination of a number of anatomical preparations, such as I am able to show you[1] in quite a variety.

FIG. 28.

Siegle's aural speculum.

Siegle's aural speculum sometimes enables us to see these adhesions very distinctly. This ingenious contrivance consists of a speculum whose external opening is wide, and covered by glass, and which has an india rubber tube connected to it laterally. The speculum is introduced into the meatus so as to hermetically close it. The air is then exhausted by suction upon the gutta percha tube, while at the same time the movements of the membrana tympani are observed through the glass.[2]

I may only briefly state, that when such adhesive processes are very extensive, that the tendon of the tensor tympani muscle, or the articulation between the incus and stapes is almost always involved. These parts, by their position, favor the formation of such abnormal adhesions.

When we come to speak of pharyngeal catarrh we may describe the various conditions that obtain in catarrh of the Eustachian tubes. I need only state here that this morbid process shows itself by closure of the tube, and with it of the whole middle ear. The air in the cavity of the tympanum, the mastoid process, and in the osseous part of the tube, is shut off by this closure, while absorption from the moist mucous membrane and its blood vessels

1 Virchow's Archiv, B. XVII, 51-80. Toynbee's Descriptive Catalogue of Preparations, illustrative of diseases of the Ear. London, 1857, I.

2 Deutsche Klinik, 1864, No. 34. Archiv für Ohrenheilkunde, 1, s. 79.

still goes gradually on. It is thus, of course, at length rarefied. The membrana tympani, which, in a normal condition of things, lies between two strata of air of equal density, is now more pressed upon by the stratum in the auditory canal. It finally yields and sinks inward. The first link in the chain of ossicles is attached to the membrana tympani. The whole chain, exactly like the drum, is soon pressed inward, and the stapes communicates the pressure to the contents of the labyrinth, which is also in a state of abnormal pressure from the long continued closure of the Eustachian tube. The chief characteristics of this condition are change in the relative position of the membrana tympani, and of the stapes, so that both lie farther inward towards the fluid of the labyrinth. We may artificially produce this state of things by closing the mouth and nose, and swallowing several times. We thus, in a measure, exhaust the air from the cavity of the tympanum. We soon observe a certain sensation of fullness and pressure in the ear, together with a certain amount of tinnitus and loss of hearing.

Closure of the tube, with its results, are observed in patients in the same way, although less noticed on account of their gradual occurrence. The symptoms just enumerated may be observed at every cold in the head, and every severe bronchitis. If the swelling of the mucous membrane only lasts a short time, the ear, as a rule, perfectly recovers its functions as soon as the equilibrium of air, before and behind the membrana tympani, is restored.

This is apt to occur during sneezing, blowing the nose, or yawning, and is made evident to the patient by a cracking sound in the ear. In yawning vigorously the pterygo-maxillary ligament is rendered tense. This is a smooth, roundish string of connective tissue, which passes close to the mucous membrane, is covered by it, and extends from

the pterygoid process to the lower extremity of the lower jaw, and is thus connected to the mucous membrane of the tube. After the equilibrium is restored the patient hears as well as before, and is freed from the pressure, fullness, and noise in the ear. If, however, the closure of the tube, with its consequences, have existed for months and years, if the membrana tympani, with the ossicula auditus, have been for some time pressed against the vestibule, and thus pressure has been exerted upon the delicate structure of the labyrinth, structural changes must occur in all the parts involved, including the tensor tympani and stapedius muscle. These effects are permanent, and do not disappear even when the causes are removed, and the connection between the pharynx and the cavity of the tympanum is restored.

Politzer has called attention to a very important consequence of long continued closure of the tube, "*secondary retraction of the tendon of the tensor tympani muscle.*" If the membrana tympani be greatly pushed inward, the attachment of the tendon on the handle of the malleus must approach the inner wall of the cavity of the tympanum. The tendon that was formerly tense, now becomes relaxed, and since the antagonistic power of the tendon—the tension of the elastic membrane—is partially removed by the outer pressure of air, the shortening must occur in the same way, in order to serve as a balance; just as contraction of the tendons of the leg results if the knee has been for a long time bent. "Of course such shortening of the tendon, when it lasts for some time, will increase the bulging inward of the membrane. Even if the tube becomes again permeable, it must act with an abnormal amount of traction exerted from within. It is very easy to see how impairments on function of varying degree may thus occur."

Tenotomy of the tensor tympani may be thought of for such cases. It would be by no means difficult to perform this operation. Hyrtl,[1] "with decorous reserve," mentions it as possibly being a remedy for some forms of deafness.

[1] Topographische Anatomie, I, sec. 154.

Subjective Symptoms.—The prominent subjective symptom is impairment of hearing. In many cases this is accompanied by disturbing sensations.

The latter are not unfrequently so insignificant in chronic aural catarrh, that the patient is not able to state with any definiteness how many years it is since his affection began. The disease shows itself only by its conseconsequences. There is an impairment of hearing that has occurred very gradually, and increased so slowly that the patient's attention is first called to it when it has reached such a degree as to interfere with the proper performance of his duties. Such cases, where the attention of the patient is not called to his affection by pain, tinnitus, or any other abnormal sensation, but only by a slowly increasing loss of hearing, have been most frequently considered as cases of nervous deafness. It is only possible to learn the true nature of the affection by an exact examination of the parts, and especially of the membrana tympani. The form denominated sclerosis of the middle ear is especially characterized by an insidious and slow course. At the most it is accompanied in the later stages by very severe tinnitus aurium.

The amount of impairment of hearing in individual cases does not so much depend on the extent of the thickening of the mucous membrane of the cavity of the tympanum, as upon the situation of such an alteration of tissue. A slight loss of elasticity in parts that assist materially in the conduction of sounds to the labyrinth, especially in the membranes of the two fenestræ, will impair the acuteness of hearing much more than even a very great change in the membrana tympani, or in other parts of the walls of the cavity. Hence it is, that we so often find the hearing so little impaired in many cases where great alterations have occurred in the mem-

brane of the tympanum. It is shown by manifold observations that very high degrees of impairment of hearing, almost amounting to perfect deafness, may occur solely from changes in the cavity of the tympanum, that is in the sound-conducting apparatus.

In recent tubal catarrh, besides the impairment of hearing, for external sounds, increased resonance of the patient's own voice is often complained of. If only one tube be closed, the tuning fork will be heard more powerfully in the affected ear, or in it alone.

The more, on the whole, the Eustachian tube is involved in the morbid process, the more variations do we find in the hearing and feelings of the patient.

In very many cases one subjective symptom—noise in the ear—is present in connection with the slowly increasing deafness, and it often forms the chief source of the complaints of the patient. The pain which occurs in chronic aural catarrh is generally of short duration, appearing only when the patient is exposed to severe cold, or to a draught of wind. It is described as a biting, gnawing pain, and soon passes away. Frequent attacks of pain, lasting for some time, are indications of sub-acute stages of the disease. In such cases we are especially apt to find partial thickenings, formations of striæ, in the cavity of the tympanum. Very acute pain may occur in acute closure of the tube, together with decided changes of an adhesive nature.

The patients often complain of pressure in the ear, of a feeling as if the ear were "stopped up," of fullness and heaviness in it. These symptoms appear generally in the morning on awaking. It is a characteristic symptom of chronic catarrh, that patients complain that in the morning, after having slept very long, they feel an increased heaviness in the ear, and greater impediment of hearing. On the other hand, the tinnitus almost always

increases in the afternoon, and after dining. Many are very much disturbed from sleep on placing the head on the pillow, by sounds which do not trouble them when up and about. The feeling of fullness and heaviness in the ear that has been mentioned, increases in many patients with the slightest causes which produce a congestion of the head, or which check the passage of blood from it. We find, then, that after drinking wine, or strong tea, after bending over at work, as, for instance, at the writing desk, or embroidery frame, or when the patient is, from any cause, bodily or mentally fatigued, that this feeling of fullness and heaviness appears. In teachers and preachers the deafness and tinnitus increase very markedly after long continued speaking.

The influence of temperature is greatly felt in these cases. Such patients hear best in a cold, dry season; and, on the contrary, the hearing power is much diminished in cold and wet weather, or in very severe summer heats. Sudden changes of temperature always have an unpleasant effect on these cases. The patients then complain of hearing sounds as if muffled, if they pass from cold air into warm, but if from warm to cold, they sometimes speak of slight pain being occasioned. The noises in the ear are not heard so much in free, fresh air, as in a closed room, especially in one that is overheated. A number of these subjective symptoms depend on the chronic, irritated condition of the nasal passages and fauces, and the reflex action of such a state upon the Eustachian tube.

In connection with the sensation of pressure and heaviness in the head, which may at times extend to attacks of vertigo and vomiting, many patients say that the increase of the affection of the ear has rendered them less capable of intellectual labor. Every long continued fixation of the attention to one point, wearies them so that they are obliged to desist. This symptom is seen in people who were pre-

viously able to read and write for hours without any sense of weariness or oppression, but who, now, cannot continue any such employment but for a short time. Patients often express their symptoms by saying that thinking has become hard for them—they feel as if pressure were made upon the brain, or as if it were in motion. A young physician afflicted with this disease, said to me, "I can't grasp an idea any more." In many cases, after long continued and severe mental labor, these symptoms of fullness and pressure increase to a severe pain in the head, which troubles the patient more than the impairment of hearing, and other symptoms.

Other patients, and also those who are not at all, at least to any sensible degree, disturbed in their hearing power, speak of an unusual irritableness, of being suddenly and without reason overcome by very sad thoughts and forebodings, which sometimes increase to weeping. For a long time I considered these last named symptoms as only accidental, and merely noted them in my history of cases, until their frequent recurrence suggested to me that they were of some importance. They were present, not only in sensitive females, but also in the most clear-headed and strong-minded men. The connection of these symptoms with the affection of the ear was also established, in my mind, by the fact that after a purely local treatment they disappeared, and that they appeared in regular order, with a relapse of the affection. It is especially to be noticed in such patients, that some forms of headache confined to one side of the head, are diminished, or entirely disappear during the use of the air douche.

In individual cases the symptoms of nervous irritation, particularly the great noise in the head, and vertigo, which may increase to the vomiting of the food, and then to that of a bilious and slimy substance, are so prominent that the ear is not recognized as the point of origin, even

by the most accomplished physicians. These attacks are then considered as consequences of acute congestion of the cerebrum. A case of this kind, observed by myself and others for more than a year, showed me to what an extent these symptoms may go. In this case, on one occasion, after several days of severe tinnitus, attacks of vertigo occurred which lasted for fourteen hours. At first they were accompanied by vomiting, and afterwards by a continual sense of nausea and choking. The seizures were usually less severe than this, but when the Eustachian tube remained for several days impermeable to the Valsalvian experiment, or Politzer's method, a gradually increasing pressure in the head, noise, and great increase in the impairment of hearing occurred just before the attacks of vertigo. The patient could induce slight symptoms of this nature by pressing his finger strongly into the meatus of the affected side. It was interesting to notice that the patient, who was affected by a severe chronic pharyngeal catarrh, and who had, at every swallowing motion, a sensation "as if a valve opened and shut," had no trace of this sensation as soon as the noise in the ears began. The walls of the tube did not then open.

Such cases, although not usually so severe as the one just mentioned, are not very rare. Whenever attacks of vertigo occur quite frequently, the ear should be examined. The impairment of hearing is frequently confined to one side, and thus it may easily escape notice.

(I have observed two striking cases of this sort, one that of a gentleman engaged in active business pursuits, whose hearing was affected on one side alone. A course of treatment by means of the Eustachian catheter relieved the vertigo, but the impairment of hearing was only very slightly benefited. The other case is that of a lady almost totally deaf on one side, while the other ear is but slightly affected. The attacks of vertigo, accompanied by nausea

and vomiting, are very unfrequent. This case is still under treatment, and has been benefited. St. J. R.)

The question now occurs, how may we explain these symptoms last described, to which the general name of "nervous symptoms" is apt to be given. We may also ask, how may they be referred to the changes in structure which are known to occur in chronic catarrh of the ear?

Some of these disturbances of sensation may be best referred to a simultaneous affection of the adjacent nasal cavities, while others may be considered as reflected neuralgia, conveyed from the nerves of the cavity of the tympanum—the tri-facial, glosso-pharyngeus, sympathetic plexus, or from the otic ganglion, to other nerve tracts.

The severe forms, however, of these nervous symptoms, especially the attacks of vertigo and vomiting, must be referred to pressure and irritation of the labyrinth-increase of the intra-auricular pressure. Long continued closure of the tube, with alteration in the position of the drum, or the stapes, or even pathological changes in the fenestra ovalis or rotunda, hyperæmia, swelling and thickening of their membranes, all of these may, under certain conditions, produce such symptoms of irritation of the internal ear.

In the lecture on nervous diseases of the ear we shall detail the physiological experiments which prove that great irritation of the semi-circular canals will produce impairment of coördinate movements, uncertainty in walking and standing. It is about the same whether these irritations have their origin in the membranous semi-circular canals themselves, or if they are caused by causes acting secondarily upon them. The latter is the case in severe pressure upon the base of the stapes, since this acts directly upon the vestibule in which all the semi-circular canals open.

Since disturbances of the proper relative position of the membrana tympani and stapes, as well as abnormal conditions on the fenestral membranes, occur much more frequently than the symptoms of irritation of the internal ear that have been described, we must inquire into the particular conditions necessary to produce these symptoms. Anchylosis of the articulation of the malleus and incus, or complete want of elasticity of the membrane of the fenestra rotunda, may play a prominent part in producing them. The former condition may produce this effect, because no movement of the articular surfaces is possible, and thus excessive pressure exerted upon the drum is directly transmitted from the malleus to the stapes. The latter prevents the yielding of the fluid of the labyrinth, and thus the pressure must act more powerfully upon the contents of the vestibule and the semicircular canals. Besides, the attachment of the stapes to the fenestra of the vestibule should be extremely free, perhaps, even, extremely relaxed. The case that I have just related went to sustain this view, because when the attacks of vertigo did not occur, the hearing was very little impaired for conversation. The patient had previously had typhus fever, and was for a time deaf on both sides. On the one side the hearing improved considerably, but changes may have remained in the cavity of the tympanum which would favor these irritations of the internal ear, if the tube were closed for a long time. How much sclerosis of the mastoid cells, with great lessening of their capability of containing air, may contribute to the same result, we shall see at a later period.

Of course much will also depend on the nature of the person affected, and the general irritability of the cerebral nervous system. The mechanical irritation required to produce great symptoms of reaction, is naturally much less with a person of diminished powers than in a patient where the nervous center has great capabilities of resistance.

LECTURE XIX.

CHRONIC NASO-PHARYNGEAL CATARRH AS ONE OF THE SYMPTOMS OF CHRONIC AURAL CATARRH.

The anatomical and physiological connection between the ear and pharynx; relations of the muscles of mastication to the ear; rhinoscopy and the pathological appearances in the naso-pharyngeal space; a case of formidable rusty-colored expectoration from the pharynx; symptoms of chronic pharyngeal catarrh; nerve supply of the pharynx.

GENTLEMEN: Having just attempted to describe the pathological changes in the ear, caused by chronic catarrh of that organ, as well as the important consequences of the disease, I consider it advisable to undertake an examination of the chronic affections of the mucous membrane of the superior and inferior pharyngeal space, before we pass on to the diagnosis and the objective symptoms of chronic aural catarrh.

If you should at first be inclined to consider this change of subject abrupt or premature, you will soon see the great importance of affections of the pharynx to the ear, and the close connection of the two parts to each other.

In most cases of aural disease you should never omit to examine the mucous membrane of the nose and pharynx. You will very often find these parts affected, and very differently in different cases of chronic aural catarrh.

The affection of the ear frequently proceeds from a morbid condition of the naso-pharyngeal cavity, or at

least is kept up by the latter. Until very recently the greater number of writers on aural disease denied the existence of this connection between aural and pharyngeal catarrh. I confess, for myself, that I consider it entirely unintelligible that this connection can be held in question when a considerable number of intelligent and unprejudiced patients, without being asked, speak of the dependence of the one inflammatory process upon the other, and when, also, the anatomical facts, physiological laws, and the results of treatment, confirm the same view.

The development, as well as the structure of the Eustachian tube, prove that its mucous membrane is a continuation of that of the pharynx. At the lower part of of its pharyngeal orifice, especially, it has exactly the same anatomical characteristics. It is thick, puffy, vascular, and contains a number of mucous glands, whose mouths we may generally see very plainly with the naked eye. The lower part of the mucous membrane of the tube, which passes without any distinct line of demarkation into that of the pharynx, is generally in the same condition with the latter, and participates in all its congestive and inflammatory conditions. Any considerable affection of the mucous membrane in the lower section of the tube, must necessarily extend to the upper parts of the ear in a purely mechanical way. The narrowing of the tube thus caused—a tube which is normally very narrow, and which very readily closes up, especially in the upper portion—will at once shut up the secretions of the cavity of the tympanum, and thus place this part in an abnormal condition. In addition to this, the cutting off of the communication between the cavity of the tympanum and the pharynx, as well as the gradual absorption of the air which remained in it at the time of the closure, will render the

pressure of the air on the membrana tympani unequal. There will only be pressure from the side of the external meatus, and thus this membrane, as well as the whole chain of the *ossicula auditus*, are forced abnormally inwards.

Catarrh of the pharyngeal extremity of the tube must then always affect the condition of the parts of the ear lying above and beyond, even where they do not themselves participate in the inflammatory process.

In a similar and purely mechanical way, thickening of the uvula, which is often increased to double its normal size in chronic pharyngeal catarrh, acts upon the pharyngeal orifice of the tube. The anterior lips of the tube are pressed against the posterior by such a lifting up of the velum, and thus its pharyngeal opening is greatly narrowed. Enlarged tonsils produce the same effect, although not directly, as has been often asserted, but the mouth of the tube may be displaced by a lifting up of the posterior arch of the palate, or of the whole uvula. In some cases the posterior extremity of the inferior turbinated bone is raised in consequence of hypertrophy, as high as the anterior lip of the tube, and may also partially displace it.

Such conditions appear to occur at times in an acute form, in consequence of an increased flow of blood to the head; for example, after a full meal, or after drinking alcoholic stimulants. This may be explained by the rich supply of this part of the mucous membrane with venous blood.

Just as often, at least, pathological conditions of the naso-pharyngeal space are continued along the Eustachian tube. A catarrh of the cavity of the tympanum often exists in connection with a pharyngeal or nasal catarrh.

This is particularly shown by examination on the dead body. On recent subjects we often find the whole mucous membrane of the middle ear, at the same time with that

of the pharynx, in a state of congestive swelling, hyperæmia, and hyper-secretion. The appearance of the different parts will vary, in accordance with the difference in structure. The mucous membrane at the tympanic orifice of the tube most resembles that of the pharynx, and of the lowest cartilaginous portion of the tube. At that point, that is, in the immediate vicinity of the membrana tympani, and at the transition of the tube to the cavity of the tympanum, the lining membrane, which in the bony portion is thin, pale, and without glands, becomes for a little distance much thicker and vascular, and has also some quite large-sized, grape-shaped mucous glands. The swelling and hyperæmia are naturally not so evident in the remaining portion of the Eustachian tube, and in the cavity of the tympanum itself, but they may be plainly seen, however, in the most of cases, even in those parts.

Daily observation and practical experience show us that neighboring mucous membranes belonging to one system, are almost always in a similar normal or morbid condition. *Johannes Müller* says: "The mucous membranes have a great tendency to communicate their affections along their course.[1] We see, therefore, that affections of the mucous membrane are often extended *per continuitatem*." Catarrhal inflammation of the conjunctive and lachrymal sac occur from coryza, and the inflammation of the buccal cavity, in typhus fever, extends through Wharton's duct, to the little glandular canal of the parotid.

It is well known that constitutional diseases—I will only name typhus fever, tuberculosis, and the acute exanthemata—very often extend themselves from the pharynx to the mucous membrane of the ear.

While we are speaking of the connection between pharyngeal and aural affections, we should remember that

[1] Hand-Buch der Physiologie, 1844.

the muscles which move the palate, and assist in swallowing, are also muscles of the Eustachian tube.[1]

The equalization of air between the cavity of the tympanum and the pharynx, which is constantly going on, is kept up by means of these muscles, especially during the act of swallowing, since they are inserted on the cartilaginous wall of the tube, and act on its walls by their muscular contraction, and thus open the passage, which is otherwise closed.

We have already spoken of these conditions, and I have referred you to the various experiments and observations which furnish insurmountable facts as to the influence of the muscles of deglutition, and of the act of swallowing itself, on the mechanism of the tube. It is certain that each normal or hindered action of these muscles, as well as of their antagonists, the inferior muscles of deglutition, has an influence upon the equalization of the air in the ear. We cannot conceive of a continuous, equable condition of the middle ear in all its parts, unless the muscular action, immediately and indirectly connected with the act of swallowing and the mechanism of the tube, be absolutely undisturbed.

It is even conceivable that the fibers of the various muscles concerned in the act of swallowing, which run so near to the surface of the mucous membrane, and which lace themselves about the glands of the soft palate, would be themselves affected, in a long continued and intense inflammation, and thus changes in structure be caused. Although there is a certain probability in this belief, nothing can be said with absolute certainty on the subject, since the parts have not been examined with reference to this view. In regard to the occurrence of recognizable pathological changes of structure in the palatine muscular

1 Petro-Salpingo-Staphylinus, or Elevator Palati, and the Spheno-Salpingo-Staphylinus, or Tensor Palati.

apparatus, as a result of chronic pharyngeal catarrh, all that we may yet certainly say, is, that the functions of these muscles are impaired by such a morbid process. Hypertrophy of the glands of the palate, swelling and thickening of the membrane of the pharynx and Eustachian tube, are the most common results of catarrh, and certainly increase the task of the muscles in question. Such results are common, and are at times very formidable. Even if the muscles do not increase in size to any extent, as we see occurs in the compensatory hypertrophy of the heart, in valvular insufficiency—although from all the facts of the case we have reason to believe the contrary—a misproportion between the power possessed and work demanded, will at least be developed. The muscles of the palate and of the Eustachian tube will not fully perform their duties, but will become relatively insufficient. Now then, a normal capability for action in this important apparatus is positively necessary in order to secure a healthy condition of the middle ear. Any insufficiency of this sort, such as may be caused by a chronic catarrh of the pharynx, will certainly, therefore, produce abnormal conditions of the ear.

The great importance of the palatine muscles for the hearing power was first made known by *Dieffenbach*, who showed that most patients with cleft palate were also hard of hearing. In such cases the muscles have no fixation point from which to exert an influence upon the Eustachian tube, and consequently it, with the entire middle ear, becomes affected. *Semeleder*, in his excellent monograph on rhinoscopy and its practical value,[1] first called attention to the fact that the mouth of the tube has an entirely different shape from the normal in cases of fissure of the palate. According to *Dieffenbach* the impairment of hearing was

[1] Rhinoscopy and Laryngoscopy. Translated by Dr. Edward T. Caswell.

always "completely relieved" after the closure of the palatine fissure by sutures.

You see, gentlemen, that when we examine the matter more closely we find a great variety of ways by which affections of the naso-pharyngeal cavity may continue themselves on the Eustachian tube and cavity of the tympanum. You now, perhaps, understand better my abrupt giving up of the subject of aural catarrh, and will believe that I am correct in stating that in a certain and large class of affections of the ear, we are obliged to consider the condition of the naso-pharyngeal mucous membrane.

Examination of the pharynx.—Most persons are not able to hold the tongue down when they open the mouth. We are thus compelled to use a tongue depressor. The best are broad and short ones, with a hinge joint, so that one part may be used as a handle. If you cause the patient to take a deep inspiration, or to articulate "A," in a loud voice, the uvula will be elevated, and we are enabled to see both arches of the palate, the tonsils, and the whole portion of the posterior wall of the pharynx. If we then press down the whole of the tongue, instead of its tip merely, we can get a deeper view, which includes the base of the tonsils, and the surrounding parts, even to the epiglottis, whose upper portion, in some men, but especially in children, is thus brought to light.

We see a great many different conditions in such an examination, for there are a great variety of morbid changes which take place in these parts. Sometimes the mucous membrane, so far as we can see, is intensely reddened, and swollen in such a manner that the *isthmus faucium* becomes extremely narrowed, and the boundaries and borders of the different parts are merged into each other. The redness may be either a bright red, or only a

bluish red, in which latter case the parts are surrounded by an œdematous border. Sometimes only single parts are affected, the uvula, for instance, which hangs down as a long and broad sac, or the tonsils are very irregular and fissured in appearance, a result of many previous abscesses, or they project out to the center of the soft palate, and have on them whitish nodules or yellow pustules. In adults of more than thirty years great hypertrophy of the tonsils is not so common as a general œdema of the mucous membrane.

Sometimes a few round elevations appear on a slightly reddened base. They are somewhat even and dry, resembling the gelatinous granules of trachoma, in the stage of diffuse inflammation, as they appear in blennorrhœa of the conjunctiva. These demarkated swellings vary in breadth and thickness exceedingly. They occur chiefly on the posterior wall of the pharynx. At times there are only a few isolated ones; again they occur in groups, and then resemble granulations. On this account this form of pharyngeal inflammation has received the name of *granular pharyngitis.*

B. Wagner[1] first described this affection from an anatomical standpoint. According to him it is an affection of the follicular tissue. The granulations are neo-plastic formations, or infiltrations of the mucous membrane. On section they are found to be of a medullary structure, and only apparently circumscribed. If laid for some time in alcohol, they acquire a white color. In more minute sections a large collection of little bodies resembling lymph corpuscles, is found in a fine reticulate connective tissue. Sometimes quite broad lymphatics are seen in this fibrous net-work surrounding the follicle in a circular manner.

The mucous membrane lying between has sometimes a strikingly pale and flabby appearance. and sometimes, on

[1] Archiv für Heilkunde, VI, 1895, s. 318.

the contrary, it appears dense and tense, as if shrinkage had occurred. Large swelling of red relaxed mucous membrane, symmetrically arranged on both sides of the pharynx, behind the palato-pharyngeal arch, are often seen. In other cases the mucous membrane, as far as we can follow it, appears very pale, smooth and thin, and traversed by thick varicose veins, while the thin, long and flabby uvula hangs down like a needle.

Irregularity in the arch or curvature of the soft palate is less common in acute than in chronic affections of the pharynx. On the one hand, we often see the uvula pushed more or less obliquely to one side, without any paralysis of the facialis. On the other hand the position of the uvula is often unchanged in facial paralysis. In one case, that of a boy, I once found that the oblique position of the uvula was due to a dentated, irregular and deep cicatrix on the posterior aspect of the soft palate. Of course it could only be detected on a rhinoscopic examination.

Very often the space between the two arches of the palate is very large, without being filled up with a tonsil, and the posterior arch is very near the pharyngeal wall, so that the entrance into the naso-pharyngeal cavity is very narrow. The latter named appearance seems to indicate a thickening of the soft palate, that is, of the broad part bordering on the fauces. We may, at times, assure ourselves of an irregular hump-like arching forwards of the soft palate, by means of a catheter introduced through the nose, and moved about in this region. The instrument will show, by means of a peculiar doughy feel, that there is a diffuse swelling of the upper pharyngeal space. We may often draw out, with the catheter, great masses of half dry, green mucus, such as are sometimes visible on opening the mouth, lying in drops or firmly adherent and incrusted on the posterior pharyngeal wall.

Rhinoscopy.—Until recently, we have been unable to examine the upper pharyngeal, or naso-pharyngeal cavity, in which the important pharyngeal opening of the Eustachian tube lies, except in those rare instances in which there was a fissure of the palate, or a considerable defect in the structure of the nasal meatus.

Bidder[1] was able to see the whole superior pharyngeal space, with the motions there taking place, as well as those of the soft palate, in a case where a greater part of the nose and cheek was removed for the purpose of extirpating a tumor. Meniere[2] saw the opening and shutting of the mouth of the tube in the act of swallowing, to the extent of about two centimetres, in the case of a patient who had a large perforation of the nose.

Humanity has to thank the energy and talent of *J. Czermak* for making practical the examination of the larynx with small mirrors. This method was several times attempted, and the way prepared for its accomplishment, but it was again given up. Laryngoscopy has now become a generally cultivated and greatly developed part of the field of science. *Czermak* also conceived the simple as well as ingenious idea of turning the face of the laryngeal mirror upward, and of thus examining the naso-pharyngeal space. This method of examination is called rhinoscopy. We use the same little steel or glass mirrors as in laryngoscopy. We generally need to fix the handle of the mirror at an angle slightly different from that on the laryngeal mirrors. We also require a tongue spatula; the jointed one already mentioned is the best, the patient being able to hold it himself. We may also require, in some cases, a broad hook for lifting up the uvula. When there is no sunlight, which is best adapted for

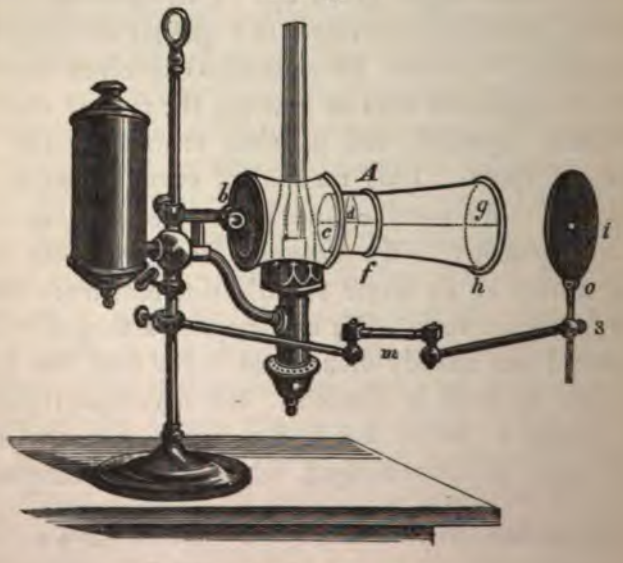
[1] Neue Beobachtungen, über die Bewegungen des Gaumens, etc., 1858, s. 9.

[2] Gazette méd de Paris, 1857, No. 19.

the purpose of illuminating the parts, I use an Argand study lamp, over which is placed an illuminating lantern (*Levin's*), by means of which the light is retained, and transmitted through a strong double convex lens. We may either allow the light to fall directly on the pharynx, or turn it upon it by means of Semeleder's illuminating spectacles. These consist of a strong spectacle frame, on which, by means of a joint, a concave lens is fastened.

In spite of all these appliances, rhinoscopy is yet by no means an easy matter, and we are only able, after long practice, to see what is to be seen. The parts to be recognized are the posterior surface of the palate, the nasal openings, with the ends of the inferior and middle turbinated bones, the pharyngeal opening of the Eustachian tube and its vicinity, and the posterior wall of the pharynx.

Fig. 29.



Tobold's illuminating apparatus.

(For the practice of rhinoscopy, I use a simple Argand burner, without the condensing apparatus, in connection with a laryngeal mirror fastened on the forehead by means of a band similar to the one sketched on page 68. *Tobold's* apparatus[1] is most recommended by laryngoscopists of the present day, as a source of illumination. St. J. R.)

The successful use of the rhinoscope may be much facilitated by the previous introduction of a polished Eustachian catheter. It is imperatively necessary, in a rhinoscopic examination, that the patient do not spasmodically contract or lift up the uvula. In order that it may be as relaxed as possible, even while instruments are in the pharynx, *Czermak* advises that the patient pronounce a nasal vowel. *Lowenberg* suggests that the patient breathe as much as possible through the nose. Any great sensitiveness of the pharynx, so that its muscles contract spasmodically at every touch, or a tendency to vomiting, with great constriction of the entrance to the throat, are hindrances which not only render the examination difficult, but sometimes prevent a thorough one, even after many trials. This state of things is quite often present in just the patients with which the aural surgeon has to deal—those who have chronic pharyngeal catarrh. However, as the surgeon becomes more skillful from practice, such cases become more rare.

The upper pharyngeal space is seldom the object of any exact anatomical observation; its normal as well as pathological conditions, therefore, are generally not sufficiently studied and understood. It is a part so hidden and out of the way, that in ordinary post mortem sections it is rarely brought into view. You should prepare for yourselves sections of the head, or take from fresh subjects the two temporal bones, or its petrous portion, by means of

[1] Vide *Tobold* on Chronic Diseases of the Larynx. Translated by Dr. G. M. Beard.

two cuts made with the saw, one passing through the mastoid process, the other through the zygomatic process of the malar bone. You will be surprised, both by the uncommon richness of the parts in vessels, and the succulence and thickness of a mucous membrane which many physicians have never seen in their whole lives, and which they have never considered as the point of origin of many of the affections of their patients. You cannot examine many such sections without finding some abnormal appearances in the parts.

The most common appearance is hypertrophy of the glands, especially in the palatine arch, where it may be so great that this part is three or four times its usual thickness. You will also find swelling and hyperæmia of the whole mucous membrane, or of individual parts. This hyperæmia may have led to greater or smaller extravasations, under the epithelium, or on the surface itself. Bloody sputa no doubt comes much more commonly from the upper cavity of the pharynx than is generally believed. The presence of fresh blood, mingled with pharyngeal sputa, shows how often hemorrhages occur under the membrane of the pharynx and in the glands, as do also its remains, the black pigment which is so often found in the vicinity of the Eustachian tube.

The blackish color of the pharyngeal sputa often arises from particles of soot which have been accidentally lodged in the naso-pharyngeal space. If in the evening the study lamp burns badly, and the soot arises, the expectorated matters are always tinged with black the next morning.

In order to convince one's self of the degree of development of the grape-shaped mucous glands of the wall of the pharynx, we have only to prepare a piece of its membrane, and hold it up to the window. The peculiar protuberant bodies (schwellkörper) on the the nasal open-

ings, and on the posterior extremity of the turbinated bone, are very often found to be hypertrophied also.

In chronic pharyngeal catarrh the trumpet-shaped mouth of the tube is sometimes very wide, its lips standing unusually far apart from each other. At times we may press white, glairy mucus from the glands, and we sometimes thus expose white and brown calcareous concretions of various size, and frequently of a sac-like shape, which are firmly buried in the tissue. Superficial roundish losses of substance are seen oftener than deeper ulcerations, and are observed not only in syphilis and tuberculosis, but where these diseases do not exist.

Folds or pockets, and bands of tissue—probably arising from suppuration and exfoliation of the coatings of glands—are found in the fossa, just behind the mouth of the tube (Rosemüller's fossa). This is an extremely vascular and glandular depression behind the tube, at the base of the skull, in the median line. Just here, where, according to *Kölliker*, great masses of encysted glands are congregated, so that the structure of the tonsils repeats itself, and where, especially in old persons, cavities are sometimes found filled with material similar to pus, I found in an ear patient who had suffered nineteen years from phthisis, a somewhat prominent swelling about the size of a cherry, which, on being incised, exhibited a pultaceous mass of a whitish yellow appearance.[1] In a post mortem section of a person thirty-five years of age, who had been deaf and dumb, I found at the same point a similar but far larger swelling filled with a thick, yellow, brownish mass, which consisted of mucus. Such cystoid structures are, perhaps, degenerated mucous glands, and are not very rare in the throat. At least I have often observed that a patient, immediately after the use of the catheter, ejected

[1] Virchow's Archiv, B. 18, s. 78.

such masses of puriform or mucous secretion, so that he would describe it as a "sac full of mucus," which had been pushed into by the catheter.

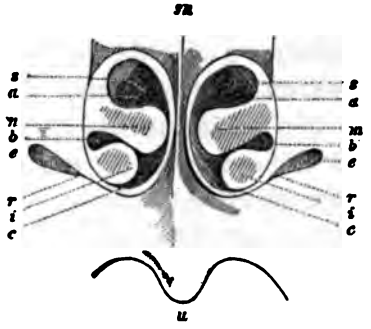
In one case the ejection of such sputa alarmed me for a time not a little, because the mingling of blood and mucus in the interior, and its external appearance, causes it to look like pneumonic sputa. The patient—an old gentleman—expectorated a great deal in the afternoon and morning, after the Eustachian catheter was used. When he showed me two handkerchiefs full of the expectorated matter, my first thought was of pneumonia. The patient relieved me of my fears by breaking out in the voice of a Stentor: "You think there is something the matter with my lungs! In the year 1848 I was first president of the House of Commons. My chest then proved its capabilities, and to-day I went again on the tribune to cry down the noise." This quieted my fears. At that time we had the good fortune to have in Würzburg the first authority on sputa, *Biermer*, so I sent the patient to him, in order that his chest and sputa might be more thoroughly examined.

At first it seemed to *Biermer* also, that the sputa was pneumonic, but he found the lungs perfectly sound, and after a thorough examination he decided that the expectorated substance which had alarmed me so much must have come from the nose or fauces. Probably it came from some kind of a cyst, or mucous gland in the pharynx, which emptied its contents after the use of the catheter. I do not know that a similar case has been previously observed. At any rate rusty-colored sputa is generally accepted as pathogomonic evidence of pneumonia.

Rhinoscopy may also give us accurate information during life as to all the above-named and other pathological conditions in the naso-pharyngeal space. Recent and little cultivated as this method of examination still is,

it has already furnished many interesting contributions to the pathology of the naso-pharyngeal space. Semelder's[1] observation on this subject may be particularly referred to, as well as those by *Czermak*, *Gerhardt*, *Turk*, and *Voltolini*. The later communications of *Voltolini* and *Löwenberg*,[2] should also be mentioned.

FIG. 30.



The posterior nares as seen in rhinoscopy. (Mackenzie.)

s n, septum nasi; s, superior turbinated bone; m, middle turbinated bone; i, inferior turbinated bone; a, superior meatus; b, middle meatus; c, inferior meatus; e, orifice of Eustachian tube; r, ridge between the Eustachian opening and the lower border of the nasal fossa.

The following may be named as among the interesting appearances observed by the rhinoscope:

1. Pharyngitis at the opening of the tube, and extended over the whole superior pharyngeal space.
2. Unsymmetrical position of the mouths of the tube.
3. Want of development of the lips of the tube.
4. Long, smooth, and semi-circular swellings of the mucous membrane in the vicinity of the tube.
5. Plugs of mucus, or a coating of mucus at the orifice of the tube.

[1] Caswell's Translation of Semeleder's Rhinoscopy and Laryngoscopy, page 45, *et seq.*

[2] Archiv für Ohrenheilkunde, 1, 2.

6. Mucous polypi of the turbinated bones, as well as pharyngeal polypi.

7. Large ulcerated surfaces in the upper pharyngeal space. These occur not alone in syphilis, but also when that disease does not exist.

8. It is by means of rhinoscopy alone that we may be able to detect an adhesion of the mouth of the tube from cicatrization. There are several such cases described in the literature of the subject. One has been lately recorded. It was observed after death,[1] however.

9. Rhinoscopy also explains certain difficulties met with in the use of the Eustachian catheter, that are caused by bulging out and hypertrophy of the nasal septum, or by anomalies in the pharynx.

Symptoms of pharyngeal catarrh.—The symptoms of chronic catarrh of the pharynx are very different in different cases. Often, even in the severest forms, the patient has no idea that he has any affection of the throat. He will, however, just remember, on close questioning, that for years, especially in the morning, he has expectorated considerable quantities of mucus. Others speak of a certain dryness, or an unpleasant tickling in the throat, which is very annoying, and demands the frequent use of cold fluids, or that the part be moistened with bon-bons, or the like, for relief. Others complain of a certain difficulty of swallowing after even the slightest cold, and of various kinds of severe pain during deglutition. With these slight complaints you will also hear of the great annoyance from the constant accumulation of mucus. It requires some considerable trouble to remove it from the throat, and the muscles thus frequently called into service may be at length forced into morbid action, and vomiting be produced.

[1] Lindenbaum, Archiv für Ohrenheilkunde, I 4, s. 295.

Perhaps the morning vomiting of intemperate persons, who all suffer from severe pharyngeal catarrh, is to a great extent produced by the straining necessary to remove the excessive pharyngeal secretion. This unpleasant symptom generally occurs in the morning, just after getting up.

As a consequence of the head being on a vertical line with the body during sleep, and the long inaction of the muscles of the throat, a considerable quantity of mucus is collected; this becomes dry and dense, and adheres quite firmly to the membrane, in little lumps. A consideration of these conditions enables us to explain the fact that the symptoms of catarrh of the pharynx are most decided in the morning, and are the more prominent the longer the patient has slept, the worse the air which he has breathed during the night, and the more he has exposed his pharynx on the evening before—that is, the more he has smoked and drank. In addition to the dryness of the mouth, which is occasioned in such patients by the "cold in the head," and by the necessity, on account of interference with nasal respiration, of sleeping with the mouth open, such patients also feel a heaviness in the head, and fullness in the ears. These symptoms will be relieved when they have used a gargle and taken a glass of water or cup of coffee, after which the mucus is loosened and easily removed. At times, however, the increased ejection of sputa continues during the whole forenoon. A patient of this class, who seemed to be a person of temperate habits, assured me that these unpleasant symptoms disappeared when he held a small quantity of brandy in his throat for [illegible] time, which, he said, "cleared his wind-pipe." [illegible] patients eject, at greater or less intervals, bits [illegible]d hardened mucus, which are always of the same [illegible]nstance that of a small ball.

[illegible]ften meet with gastric symptoms, in connec-[illegible]onic catarrh of the pharynx, which must

result from the contact of the secretion of the pharynx with the mucous membrane of the stomach. The secretion of the pharynx is sometimes so excessive as to be almost a pharyngeal blennorhœa, and the whole of the mucus cannot be ejected, but is swallowed, and passes down into the æsophagus of itself. Although we know very little of the chemical constitution of the sputa of the pharynx, yet we may believe that the stomach will not tolerate it in any great quantity.

Many observations have convinced me that many forms of the neuralgia which so often occurs in chronic catarrh, and which generally appears as a pain in the forehead and back of the head, are closely connected with this affection. In order to convince you of the possibility of such being the case, I have only to call to your mind the many headaches which depend on affections of organs that are remotely situated. Severe pain in the head is very often one of the symptoms of diseases of the eye, stomach, and kidneys, as well as of the uterus. Of course we cannot relieve such a pain until we reach the cause.

Nerves of the pharynx.—The palate and pharynx are parts very richly supplied with nerves.

The trigeminus furnishes motory as well as sensory fibers; the motory from the pterygoidens internus of the third branch, and the sensory as well from the second as the third branch. The spheno-palatine ganglion also, communicates with pharyngeal branches, and with the descending palatine nerves, and the otic ganglion, with branches to the tensor of the soft palate. The facial nerve should also be mentioned, from which, according to most authors, a little branch goes to the uvula—the glosso-pharyngeus, from which, as is well known, a great part of the sensation as well as motion of the pharynx proceeds. The pneumogastric sends two branches to the mucous membrane and

muscles of the pharynx. There are numerous connections of the *accessorius Willisii* (spinal accessory) with the pharyngeal branches of the pneumo-gastric, and just as branches from the pneumo-gastric unite to form a nervous plexus in the pharynx, so also is a plexus pharyngeus formed from the sympathetic.

Thus we see that there are few parts of the human organism that are so immediately connected with so many different nerve tracts. Is it probable that pathological conditions in parts so abundantly and variously innervated, only declare themselves by local symptoms? May we not rather believe that they may excite affections in other nerve tracts, and in other organs of the body? If pharyngeal affections are studied more closely, we shall find more and more facts which will demonstrate their connection with other diseases in a manner much more evident than I have indicated in the foregoing remarks.

It still remains to be said, that the affections of the upper and lower portions of the pharynx often produce a bad odor from the mouth and nose. Sometimes we perceive this at a considerable distance, as soon as the patient breathes with his mouth open. More commonly we first notice it when examining a case, and the patient makes an expiration with his mouth open. It is also very unpleasantly perceived in the use of the catheter. It has something of the odor of stinking cheese. Not unfrequently it is not noticed by the patient, but it is unspeakably sickening and uncomfortable to the surgeon if he is at all sensitive to odors. An odor resembling that from fresh meat may also be considered as one of the unpleasant exhalations occurring from pharyngeal catarrh.

Nasal catarrh.—Chronic catarrh of the nasal mucous membrane is very frequently connected with the same kind

of an affection of the ear and pharynx. There is also a bad odor from the nostrils of the patient, when this affection exists, one that recalls the odor of black currants. It occurs particularly in females, and is almost always increased during the period of menstruation, and sometimes appears at this time only. The patients do not seem to be aware of such nasal exhalations, and they generally assert that there is no unpleasant odor from the nose.

In chronic nasal catarrh the secretion is not so often increased as diminished. Most of its victims suffer from the so-called "stoppage in the head." (Stockschaupfen.) The nose is very dry, they seldom need a handkerchief. They complain very often of an unpleasant sensation of thickness and stoppage in the nose. Its permeability for the purposes of respiration is more or less impaired by the swelling of the mucous membrane.

If the secretion from the nose has been very abundant for a long time in an adult, we must consider the possibility of the existence of polypi. An exact examination will sometimes detect these where the patient, and even the physician, had had no suspicion of their existence. Nasal polypi are often overlooked if they are not so large that on a vigorous expiration they are forced towards the external nasal meatus, or when they do not completely stop up the affected side. It is a question whether they do not often take their origin from the antrum Highmoriani.

Luschka and *Giraldes*[1] have shown that cysts and actual polypoid proliferations from mucous membrane, very often occur in this cavity. In sixty post mortem examinations, made without choice, soft polypi were found in the antrum, five times. Inflammatory affections of this cavity may be sometimes detected on the living subject. Such patients speak of a pain limited to the cheek bone,

[1] Virchow's Archiv, B. VIII and IX.

of a circumscribed sense of heaviness, and a sensitiveness which at times increases to a toothache.

As is well known, the superior dental nerves run close beneath the covering of the antrum, so that when its mucous membrane is swollen these nerves are apt to be pressed upon. In such cases, masses of yellow mucus are often evacuated, generally in large quantity at one time, and I may venture the supposition that they proceed from the adjacent cavity.

For the purpose of examining the nasal mucous membrane we may use an aural speculum, and illuminate the nasal cavity by means of the concave mirror. *Kramer's* valvular speculum is well adapted for the same purpose, the nasal passage being capable of distension. The halves of the speculum may be made a little flatter than in the one used for the ear. The anterior portion of the inferior turbinated bone is sometimes so much thickened that the inexperienced examiner may mistake this superficial thickening for a polypus.

We have already said that this same bone sometimes appears in rhinoscopy as a bluish red, irregular swelling projecting into the pharyngeal orifice of the tube.

(If the face of the patient be turned towards a window or other illuminated surface, we may expose the nasal cavities very thoroughly, in most cases, by simply pressing upon the nasal septum with the thumb until the alæ become widely spread apart. St. J. R.)

LECTURE XX.

SIMPLE CHRONIC CATARRH (CONTINUED).

Comparative frequency; hereditary predisposition; appearance of the membrana tympani; auscultation of the ear; kind and degree of the impairment of hearing; participation of the mastoid process; prognosis in accordance with the different varieties of chronic catarrh.

GENTLEMEN: Observations on the cadaver as well as on the living subject, teach us that chronic aural catarrh is by far the most frequent of all the affections of the ear, and that it thus becomes the most common cause of impaired hearing.

Chronic catarrh of the ear is an affection of every time of life. It occurs in early childhood. It then developes itself more frequently from an acute or sub-acute affection, but it is the most common cause of the impaired hearing of advanced life.

It cannot be denied that there may be an hereditary tendency to this disease. I know families that are generally healthy and long-lived, in which scrofula and phthisis pulmonalis never occur, where, for generations, the greater number of the members of these families, no matter in what different circumstances they may live, are affected with chronic catarrh of the ear, in consequence of which not a few of them have become somewhat deaf. When we consider that certain family similarities, which have

been transmitted through several generations, are founded in some similarity in the construction of the skull, we may ask if the same thing may not occur with reference to the osseous part of the organ of hearing, so that peculiarities in its structure may be inherited, just as well as a particular shape of the nose.

The amount of space in the cavity of the tympanum as well as the width of the bony portion of the tube, varies very much in different persons. It cannot be denied that a certain amount of malformation of the part would favor adhesions, frequent closure of the tube, etc. This question might be answered, as I believe, by anatomical examinations and exact measurements. Of course we often meet with this affection in persons with scrofula and tuberculosis, as well as in persons who are disposed to catarrhal affections of other mucous membranes.

Catarrh of the Eustachian tube, or tubal catarrh, very often occurs in children and very old persons. In the case of the former, the fissure-like shape of the pharyngeal orifice, as well as the relative density of the pharyngeal mucous membrane, may explain the fact that at each cold, closure of the tube so readily takes place. In old persons, on the contrary, we seem to have an abnormal relaxation of the parts, and a want of power of the muscles of deglutition. They are consequently not able to draw away the membranous wall of the tube with sufficient regularity and force. This relaxation and want of power seem to occur quite frequently in anæmic and debilitated persons — for example, in chlorotic females, convalescents, etc. The same state of things must occur in the case of paralysis of the tri-facial, it being connected to the internal pterygoid nerve, which supplies the *tensor palati*. It may also occur, perhaps, in paralysis in that part of the pneumo-gastive which furnishes motory nerves to the *levator palati*. How far diseases of respiration may affect

the functions of the tube, and thus of the ear, we cannot determine until the influence of the movements of respiration on the equalization of air in the ear is shown to be one that is absolute and constant.

A sclerosing and thickening process very frequently occurs in marasmic individuals who have a dry and delicate skin, and a very irritable nervous system. Hence, when it takes place in the middle ear, and causes dullness of hearing, the affection is generally considered as *nervous deafness*. This form of impaired hearing is not frequently found after a severe course of hydropathic treatment, or after the careless employment of sea baths.

Diagnosis. — How may we recognize chronic aural catarrh? The appearance of the membrana tympani plays a prominent part in the diagnosis of this affection. Its position, as the elastic and transparent boundary wall of the cavity of the tympanum, as well as its anatomical structure, possessing as it does on its inner surface, a continuation of the mucous membrane lining the middle ear, renders it a good stand-point for a diagnosis. The morbid changes that occur upon it in the sclerotic form of chronic aural catarrh, are the least striking. In this variety of disease the membrana tympani may be exceedingly brilliant, and, as it were, abnormally stretched over the cavity. At the most it is somewhat more opaque than normal on the periphery, or there is a reddish yellow mingled with its color. This mingling of colors is most strongly marked in the center of the posterior half.

In true chronic catarrh of the cavity of the tympanum, on the contrary, we find quite a variety of abnormal conditions on the membrana tympani. These alterations proceed from morbid processes in the mucous layer of this membrane. They are frequently propagated upon the *lamina propria*, or fibrous structure, whose internal layer,

or the one consisting of circular fibers, is dependent for its nutrition upon the layer of mucous membrane lying upon it. The outer surface is generally of a normal brilliancy, except in very old, or somewhat acute cases, where it looks dull, as if it had been breathed upon. The epidermis and the cuticular layer are then somewhat affected. The light spot is very often altered. It is only rarely that it is broader than normal. Its boundaries are often indistinct, while it does not extend so far towards the periphery, or its course is interrupted in various directions. Sometimes it is reduced to a small point, or to a small line. It may be entirely absent, or only a slight indication of its presence may exist. All these are conditions which we must refer to some abnormal condition in the curvature or tension of the membrana tympani, if there are not other appearances which show that the superficial layer of epidermis and the cuticular layer are alone affected.

Vessels are only seen on the membrana tympani when recent congestive conditions are also present. They then run along the handle of the malleus, or behind it, looking like fine red lines. The malleus is usually very distinct, the corium not being thickened. It appears frequently very prominent, and it is dragged abnormally inwards, so that it appears more or less shortened in the perspective, in which case the little nodule at its upper extremity—the short process of the malleus—is so much the more prominent.

The membrana tympani is not infrequently very convex, and there are points where it is more drawn inwards than at others, as we have already mentioned in speaking of adhesive processes on the cavity of the tympanum. They vary greatly in position, extent, and shape. Most frequently the anterior half of the upper part of the membrane lies abnormally. The appearance of the membrana tympani in chronic catarrh of the cavity of the tympanum

may be distinguished from that of the normal condition, in that it is less translucent, and appears somewhat thickened. It then seems very markedly drawn inwards from the sharply demarkated anterior edge of the handle of the malleus. In other cases, in connection with this increased concavity of the membrana tympani, the handle of the malleus appears curved inward like a saber. The natural pearl grey appearance is changed to a dark grey; the color of the membrane, in the long-continued course of the disease, passes through all the intermediate changes, from a whitish grey to a pearl white; from a bluish to a yellowish grey. The periphery is often thicker and the most intensely grey. It often even appears as a distinctly defined whitish ring of various width. On the border where the mucous membrane of the cavity of the tympanum is continued upon the inner surface of the membrana tympani, where, in a normal condition, the mucous membrane is most developed, the abnormal relaxation, or thickening, as a rule, is seen first, and takes place to the greatest extent. While in the normal membrana tympani the mucous layer is the thinnest of all, when a catarrhal process has occurred, there is often very considerable swelling and hypertrophy, so that it is thicker than the whole membrana tympani should be.

Even a slight degree of relaxation and exudation may very greatly impair the transparency of the membrana tympani, and cause very great changes of color. I need only to remind you of what we learned as regards the color of the membrane, that is, that it results from a combination of colors. Thickening of the membrane acts, therefore, not only on the color of the drum, by changing its own peculiar hue, but by preventing the passage of any rays of light. Hence the mingling of a yellowish tint is prevented. This tint, in a normal membrana tympani,

depends upon the reflection from the promontory through the membrane.

We do not always, however, find the appearance of the membrana tympani much changed in chronic catarrh of the middle ear, where the cases are recent, although the catheter and other means of diagnosis, may distinctly indicate the existence of a catarrh. It often only appears a little dull and moist, with a slight yellow color mingled with its normal tint. The color is thus not so even—some points are less translucent. In general the appearances are not equable, either in color or density, but exist in different places to a very different extent. We often find in the posterior half of the membrane a spot in the form of a whitish grey, opaque half moon, which lies between the outer edge of the membrane and the handle of the malleus, so that there is a portion normally translucent in each direction. *Wilde* has likened this half moon shaped opacity to the *arcus senilis* of the cornea. It may be seen in young persons, however, and is by no means a constant appearance in old ones.

According to *Politzer*, who examined several such cases with the microscope, these spots, looking like tendon, were found to be "depositions of fat corpuscles and granular matter between the fibres of the membrana tympani." We find also, in the same position, other calcareous deposits, beginning generally in a round-shaped spot. This spot may unite with the posterior half of the half moon shaped one, and thus form a ring in the shape of an elongated horseshoe. These calcareous deposits are easily distinguishable from the tissues round about, by their yellowish white, or pure white color, and are not to be mistaken. They resemble atheromatous spots on the internal coat of an artery. Sometimes they involve all the layers of the membrana tympani, and sometimes the outer surface of the membrane is unchanged, so that it is

continued over these spots with an unaltered and superficial brilliancy. These calcareous deposits are seen in early youth, and are by no means infrequent.

In speaking of purulent affections we shall again allude to these calcareous degenerations of the membrana tympani. They very often exist, even when very large, in conjunction with very good hearing power, as numerous observations show. I have found very extensive calcareous degenerations on the membranæ tympani of students who have been attending my lectures, who stated that their hearing was not at all impaired.[1]

Besides these changes, radiate striæ, running from the "umbo" to the periphery, are sometimes seen. Sometimes they do not appear until after the air douche, or inflation of the membrana tympani, has been employed. There are also peculiar whitish points to be sometimes seen on the membrana tympani, anteriorly and above. They are certainly situated in the mucous layer, but I can give no more exact idea as to their nature.

We have already briefly shown, in one of the preceding lectures, how adhesive alterations of the membrana tympani, that is, its abnormal adhesion to portions of the walls of the cavity of the tympanum, may exhibit themselves by greater concavity of the whole membrane or by depressions of various parts. These conditions may be more distinctly seen during the administration of an air douche. These morbid conditions are found not only as a result of acute catarrh, but they may be developed in the course of a chronic affection of the same kind.

Apart from the already mentioned changes in the position of the malleus, and also in the curvature of the whole membrana tympani, as well as the drawing inwards of the portion lying in front of the upper part of the handle of the malleus, the indications of abnormal adhesions are

[1] Schwartze, A. F. O., I, s. 142. Chimani loc. cit., s. 171.

found in the most different parts, and vary very much in appearance, so that no one description suffices for all the conditions. They occur very often in the posterior and upper part of the membrana tympani, behind which, at a very short distance, we find the long process of the incus, and the head of the stapes. Corresponding to an abnormal adhesion between the membrana tympani and these points, we sometimes find a yellowish point in its posterior half, above the center, which often lies in a superficial depression. The shape of the head of the stapes, with the arch, which its posterior portion forms with the process of the incus, may then be at times very distinctly seen from without. A yellowish line behind the handle of the malleus, and running parallel to it, shows that the long process of the malleus is pressed towards the membrana tympani, or even united to it. A fine whitish line extending backwards from the short process of the malleus, is also sometimes seen posteriorly and above, which seems to indicate an adhesion of the posterior pocket. This so-called posterior pocket is a cavity on the inner surface membrana tympani, formed by a reduplication of the membrane. It may be also an indication of an abnormal approximation of the *chorda tympani*, which runs along the free margin of this pocket. Both these conditions are not unfrequently met with on the dead subject, and they are often described.

Tubal catarrh.—True catarrh of the tube is indicated by a peculiar condition of the membrana tympani, which may be generally described as a change in position or curvature of the membrane. After a closure of the tube that has existed for some time, we find its center, especially, very much depressed. It is abnormally concave, and looks as if sunken inward, or more properly, as if pressed inward. This increased concavity of the membrane is most distinctly seen in the appearance of the handle of the mal-

leus. This seems much shorter in the perspective. The short process appears more prominently above it, and with it the contiguous uppermost portions of the drum, which are demarkated from the other parts of the membrane by more or less decided folds or edges. Corresponding to this pressing inwards of the membrana tympani, the distance between it, and the parts of the cavity of the tympanum lying behind it, is lessened. Thus we often see the promontory through the membrana tympani, especially the edge above the niche for the *fenestra rotunda.*

We are most frequently able to distinguish the vertical process of the incus behind the membrana tympani, upon which it really lies. The triangular light spot is often broader, but at the same time shorter than normal, and very indistinct. Not unfrequently above or behind the short process of the malleus we see a diffused reflection. The color and thickness of the membrane may be at the same time completely unchanged. It often appears thinner, as if atrophied. *Wilde* calls this condition "*collapsed membrana tympani.*" Sinking inwards of the membrane is, however, less often a result of primary weakness—an independent atrophy of the fibrous portion of the membrana tympani—than it is a consequence of long-continued, unequal atmospheric pressure, that is, pressure exerted on the outer surface of the membrane only, by which, in the course of time, its equable condition has been altered, and which, as it seems to me, has caused a thinning and atrophy of its fibrous structure. We may often see how much the membrana tympani has changed in its position of equilibrium, by causing the Valsalvian experiment to be practiced, or by blowing in air through the catheter. The drum then moves very much outward, but immediately falls back into its former position.

If a general thickening of the membrana tympani has resulted from an affection of the cavity of the tympanum,

occurring at an earlier period, or simultaneously, of course all these indications of the closure of the tube are less distinct. On the other hand, the appearances are much more marked when only certain parts of the membrane are thickened. If, for example, a circumscribed thickening of the periphery of the membrane has occurred, the center and periphery are markedly distinguished from each other, both in color and curvature. A broad zone of thickened tissue, and of whitish grey appearance, will remain in the normal plane, while the transparent, greyish red center sinks inwards, like a funnel. This line of depression marking off the center from the periphery, is generally most distinctly seen on the anterior and lower part of the drum. We often see, on the angle or edge thus formed, a characteristic brilliant line, in the region of the triangular spot of light. (*Politzer.*)

Thus much, gentlemen, as regards the exceedingly varying appearances of the membrana tympani, which you may find in the objective examination of patients. Allow me now a few words as to the value of these in individual cases, so that you may not expect too much from one means of diagnosis. Although an exact examination of the membrana tympani is imperatively necessary for the proper estimation of a case of disease of the ear, and although it is one of the most important standpoints for observation as to the condition of the middle and external ear, you must not think that the appearance of this membrane alone, is sufficient for the determination of the nature of a morbid process in the organ of hearing, and for the explanation of the existing impairments of function.

On the one hand, I need only to call to your mind how many of the previously mentioned abnormities of the membrana tympani we have found in some of our fellow students, who not only believe that they hear well, but

who actually show themselves capable of fulfilling all the demands made upon their hearing power by the practice of auscultation. Catarrhal affections of the middle ear occur so very frequently, especially in infancy and childhood, that it is not surprising that a great many of them run their course without any marked impairment of the hearing, although certain changes on the membrana tympani may remain.

Politzer has shown that some opacities of the membrana tympani may be referred to congenital anomalies of development.

You will easily understand, furthermore, that the medium which transmits the vibration from the outer to the middle ear, is much less important for the final perception of sounds by the auditory nerve, than that which conducts the sound from the middle to the inner ear. As long as the latter, that is, the fenestræ of the labyrinth, and especially the structures about the fenestra of the vestibule—the stapes and its membrane—are perfectly normal, the membrana tympani may be greatly altered, without any marked impairment of the hearing.

We can never decide as to the degree of the impairment of function from the appearance of the membrana tympani alone.

In medico-legal cases—for example, in the case of the examination of conscripts—where we cannot admit the testimony of the person being examined, it is especially important to remember the proper value to be given to the appearance of the membrana tympani, in deciding as to the hearing power.

The mucous layer of the membrana tympani is generally in the same condition with that which lines the cavity of the tympanum. The normal or morbid conditions in the latter are generally continued upon the former, although

there are exceptions to this rule. According to numerous pathological investigations, catarrhal processes occur in the cavity of the tympanum which may localize themselves on individual parts, for example, on the fenestræ ovalis and rotunda, without there being any affection whatever of the mucous membrane of the membrana tympani. There may, therefore, be no morbid alteration of the membrana tympani in a decided case of catarrhal deafness. This is, however, an exceptional case. The membrana tympani, as a rule, furnishes us with very valuable conclusions as to the condition of the middle ear, and as to the kind and nature of the morbid processes located in that part.

The statement of the patient as to the history of the case, the influences that affect his hearing, making it better or worse, are also valuable assistances in the diagnosis of chronic aural catarrh, although not always. So, also, are the examination of the pharyngeal space and the use of the Eustachian catheter.

We have already spoken of the course and subjective symptoms of chronic aural catarrh, as well as of the morbid processes in the pharynx. We have also learned the various results of auscultation on blowing air through the catheter, but we must refer to this subject once more. If we wish to give an exact opinion as to the condition of the mucous membrane of the tube, we can scarcely dispense with the use of the catheter, and the practice of auscultating the ear. We thus learn whether the tube is swelled, if it is of normal width, or contracted, that is, if the resistance from its walls to the stream of air, be normal or increased, and if there be any abnormal amount of mucus in the tube or in the cavity of the tympanum.

It is certainly conceivable that some adhesive processes which act very materially by lessening the space in the cavity of the tym-

panum, but of which the appearance of the membrana tympani gives no clue, may exert an influence on the sounds heard on auscultation, and that thus we may obtain an idea of their presence.

Among the different sounds that are heard, sometimes, certain peculiar short and heavy, as well as some vibratory sounds occur, which we know arise from the middle ear, because of their seeming nearness to the ear of the examiner, and which are essentially different from the "striking sound," depending on the striking of the air upon the membrana tympani. I can only indefinitely indicate the sub-varieties, and have therefore not mentioned them before. We shall only obtain decided conclusions as to their nature by a post mortem examination of persons upon whom such sounds have been heard; or possibly by auscultatory experiments on a cadaver, which is at the same time anatomically examined.

Some abnormal conditions of the membrana tympani, for example, the radiate striæ, are often not seen until after the air douche has been employed. An examination during the air bath also informs us as to the elasticity, mobility or abnormal fixation of the membrane. We have no other certain means of learning these latter-named conditions.

Thus, we must consider catheterization of the Eustachian tube as very important in the diagnosis of chronic catarrh, but we must, on the other hand, guard ourselves against the error of overestimating it, and from forming conclusions not justified on strict criticism, or on an anatomical basis. If the stream of air enters fully and freely into the cavity of the tympanum, without any rustling sound, it proves nothing more than that at the moment of examination there is no abnormal swelling, and no morbid secretion of the mucous membrane. It is by no means proven that such conditions did not formerly exist, and that in the present case the impairment of hearing does not depend upon frequent and long continuing closure of the Eustachian tube, or upon changes in the mucous

membrane of the cavity of the tympanum, in other words, upon a catarrhal process.

In many cases the appearance of the membrana tympani, the statements of the patient, in short, all the other symptoms, indicate that there is a chronic catarrh of the middle ear, with a thickening process of the mucous membrane, or that the tube has been closed for a long time, and yet the air passes through the tube without any sort of hinderance, without any increased resistance, and without any sound indicating increased secretion. We can estimate this resistance by the amount of pressure required on the air bag. We very frequently find in decided cases of chronic catarrh, particularly those that have existed for a long time, that the stream of air enters with an uncommonly full and loud tone. This is most strikingly seen if the patient has been for some time deaf in one ear, in consequence of catarrh, and the same affection has more recently occurred on the other ear. While the air strikes freely and fully upon one drum, in the other, more recently affected, and the one with better hearing power, it meets with considerable resistance, and enters in a fine whistling stream, or only during the act of swallowing.

After a long continuing inflammation a certain dryness of the surface, and a shrinkage of the connective tissue basis occurs, just as we may see, after severe trachoma, when an abnormal dryness of the conjunctive, and a perfect absence of secretion result. (*Xerophthalmos.*) This condition, which may be observed on the living subject, may be frequently found in an examination of the cadaver.

I have several times called your attention, in the pathological specimens which I have presented to you, to the marked width of the upper portion of the Eustachian tube. It occurs in cases where a severe suppurative inflammation in the cavity of the tympanum had existed for some time. Here we might conceive of a distention

of the walls by a collection of secretion, or of a disturbance in the nutrition connected with subsequent atrophy of the bones. Such a widening also occurs in old cases of catarrh of the ear which have left behind morbid changes in the cavity of the tympanum.[1]

An aural catarrh may also occur which localizes itself chiefly in the cavity of the tympanum, and causes little or no alteration in the tube. In very many cases every anomalous symptom in the tube, or in the sounds heard in auscultating the ear, may be absent, and yet the impairment of hearing be caused by a pathological condition of the cavity of the tympanum, which possibly itself proceeded from a primary affection of the tube.

If I have spent too much time in discussing this point, it has been because the most of practitioners only consider themselves justified in making the diagnosis of "catarrh of the ear" when moist rattling sounds occur on the use of the catheter, or if the permeability of the tube is removed or impaired. The name "tubal catarrh," which is so limited in its signification, is also frequently used by physicians to designate catarrh of the middle ear.

Of course too slight a consideration of the changes in the cavity of the tympanum goes hand in hand with an overestimated value of the signification of the results of auscultation, which can furnish conclusions as to the condition of the mucous membrane at the time of examination only.

This want of recognition of the condition of things is not confined to the aurists of a former period, and general practitioners of the present day, but it is most clearly expressed in the writings of some modern aural surgeons. You will see that in this way a great number of cases of catarrh, especially those where the morbid process is interstitial, are overlooked, or referred to other causes

[1] Virchow's Archiv, B. XVI, sec. 10, 11; ibid., B. XXI, p. 299.

than the true one. We shall have occasion at another time to notice that these cases have been classed together under the head of "nervous deafness," and that thus the nervous affections of the ear have taken too large a place in the diagnosis of aural disease.

Catheterization, or, to speak in more general terms, the administration of an air douche to the ear, furnishes valuble assistance in the diagnosis of individual cases, in other respects than those mentioned. If the patient hears better immediately after its use, if the tinnitus aurium is markedly diminished by the air bath, we are able to say that these impairments of function depend upon morbid conditions which may be influenced in a purely mechanical way. They thus allow of at least a relatively favorable prognosis. The subsequent examination of the membrana tympani, and further general observation, will determine the degree and duration of the improvement. The case can then be more exactly analyzed, since these mechanical effects may be produced in various conditions of the parts, such as closure of the tube, excessive secretion in the Eustachian tube or cavity of the tympanum, abnormal adhesions, and so on.

The kind and degree of the impairment of hearing may also indicate to some extent the parts that are especially affected. The more frequently do sudden changes occur in the hearing, the more is the Eustachian tube involved. Every Eustachian tube is more permeable in dry weather, and does not open so readily when there is much moisture in the air. All mucous membranes to which the air is accessible, become heavier and thicker from receiving water from the atmosphere. In moist weather there is also an increased secretion of mucus in the tube, which causes its walls to be more firmly united, so that there is more muscular action required to draw them apart.

A slight swelling of the mucous membrane, that in a

person with healthy ears would cause no unpleasant symptoms, will have a bad effect upon the ear in a person whose Eustachian tube has at all times a small caliber, on account of chronic hypertrophy of the mucous membrane and the glandular layer, and which only opens on an energetic swallowing action, or upon a person whose impairment of hearing is made more noticeable by any, however slight, diminution of the hearing power. Hence, such patients always do well to restore the communication of air between the pharynx and middle ear several times a day, by closing the mouth and nose, and then forcing in the air. Wilde calls this procedure "inflation of the membrana tympani."

When, however, the impairment of hearing is not affected in this way, the predominant cause is probably in the cavity of the tympanum. When the impairment of hearing is very great, we are obliged to believe that changes have occurred on the most important parts (acoustically), that is, on the two fenestræ leading into the labyrinth. I must call your attention, however, at this point, to a great gap in our knowledge. We have no means, as yet, of determining, on the living subject, the particular seat of the morbid changes, that is, any more exactly than has been just indicated.

Politzer says, on this point: "We have no way of determining whether a given impairment of function depends on an adhesion of the head of the malleus to the upper wall of the cavity of the tympanum, for example, or upon a diminished mobility of the stapes in the fenestra ovalis."[1] Perhaps an examination with the tuning fork, of which I have already spoken in detail, may lead to some distinctive conclusions on this point.

In the observations thus far made on the subject of

[1] Archiv für Ohrenheilkundes, I 1, s. 60.

chronic catarrh of the ear, one part of the organ has been left completely unnoticed. This is the mastoid process. Let us now see what may be said of the participation of this section of the ear in the affection just named.

The number and extent of the air cells of the mastoid process, or, in general terms, their development, density, and porosity are so various that in persons of the same age great differences are observed. With our present knowledge we are not always in a condition, in a given case, to say if a certain appearance in the mastoid process should be characterized as morbid or physiological. You can see how difficult it is, under these circumstances, to obtain positive conclusions as to the pathological changes on the mastoid process, even on the cadaver, and how carefully we must proceed. In some cases of thickening of the mucous membrane of the cavity of the tympanum of one ear, I found that the mastoid process of the same side had very small cells, being quite solid in structure, while on the other side the air cells were very large. It can not certainly be decided if such difference in cell development may not occur without the existence of chronic catarrh. However, there is a very great probability, when the middle ear has been for a long time in a condition of congestion and hyperæmia, that the space containing air gradually begins to enlarge by means of increased secretive power, and that through increased formation of bone a hyperostotic tendency may also occur, such as is often seen in all parts of the body, and which ends in chronic inflammation of the periosteum. A fact that goes to show that the mastoid process often participates in the chronic inflammations of the ear, is the one that many patients complain of frequent pain in this part, and when there is an exacerbation of the catarrh, they have a sensation of hearing or fullness behind the ear. How far such an increase in density of the mastoid process affects the other

parts, and how much it injures the hearing, we do not know, since no observations have been made as to the greater or lesser capability of the mastoid cells for containing air during life. It is probable that we may obtain some light by auscultation of the ear, and percussion of the bone, and by ascertaining the degree of hearing power, by placing the watch over the mastoid process, as compared with other results. It is, however, as yet, advisable to simply consider all these observations without being in haste to draw conclusions from them.

Let us turn to the consideration of the physiological importance of the mastoid process, in order to determine what results must obtain from the described altered condition of the air-containing property of these cells. It is a generally accepted opinion that the purpose of these air cells, this porous structure, is to give this firm support of the soft parts a certain lightness. But there must be some further purpose than this. The air cells of the mastoid process increase the quantity of air in the ear, which is set in motion by means of the acoustic vibrations. They are—with every circumscribed fixed body, and every circumscribed quantity of air in the vicinity of the labyrinth—to be compared to a resonator, or sounding board. We cannot say how far any diminution in size of these parts may place the hearing below the normal standard.

This hollow space in the vicinity of the cavity of the tympanum has also a greater importance, in that it is a sort of air reservoir, by means of which all sudden changes in the cavity of the tympanum, such as often occur as to the quantity of the air, may be equalized, and thus rendered less effective. We have noticed several times, previously, how, in simple swallowing with the mouth and nose closed, that the air was considerably rarefied, and the membrana tympani pressed inwards, as

we may determine by an examination, or by Politzer's aural manometer. This same state of things occurs also in a strong respiratory action, for instance, in sneezing, spasmodic coughing, or violent blowing of the nose. We also know that a strong condensation of the air in the middle ear, with pushing out of the membrana tympani, may be noticed when air is pressed from the lungs into the ear by the Valsalvian experiment, or by the catheter, or Politzer's method.

Again, such a sudden increase in the pressure of the air occurs in the cavity of the tympanum, but the membrana tympani is pushed inward from a very loud report, such as that of a cannon, or the blast of a trumpet, beating of a drum, etc., near the ear. A great effect will be produced from such a change in the pressure of the air upon the small quantity of air in the cavity of the tympanum, and in the upper parts of the tube, and how easily must a solution of continuity occur in one part or the other of the middle ear. Either a laceration of the membrana tympani, of the membrane of the fenestra rotunda, a pushing of the stapes into the vestibule, or a separation of the extremely delicate articulation between the incus and stapes, or other injury may occur, according to the force and direction of the powerful movement of the air. All these accidents will be less likely to happen when the pressure of the air is more equally divided by having access to the various spaces.

Thus, sclerosis of the mastoid process is to be reckoned among those conditions which favor the occurrence of those severe symptoms depending upon increase of the intra-auricular pressure, that we have already described in our remarks on closure of the tube, and its consequences.

Prognosis.— The prognosis of chronic aural catarrh is in general terms a favorable one. We are able to act directly upon the seat of the affection with the help of the

[illegible]

[illegible]

[illegible]

an injurious impression which may be of itself an affair of slight moment.

I need only to recall to your mind the effect of adhesions or thickening of the mucous membrane of the middle ear, as we have described them in speaking of acute catarrh. If, therefore, the pathological state has advanced to a certain degree, it contains in itself all the requirements for an increase in the morbid condition, both in an anatomical and functional respect.

It is well, therefore, in such cases, not to have too great expectations in our own minds, or to cause them to be raised in those of our patients, as to what art can do, but we should be contented if we are able to stop the disease in its progress, and permanently retain the hearing power that may exist. Without direct local treatment the affection must finally lead to complete deafness.

We may possibly esteem such an amount of surgical assistance too lightly. It is something, however, to preserve a person—who has been growing deaf from ten to twenty years, and who in ten years more must be dead to the ordinary intercourse of life—from the entire loss of his hearing power.

Compare, if you please, what may be done here, with that which is accomplished in severe inflammations of the other mucous tracts, although they have for years rejoiced in scientific treatment, and although, in the latter class of affections, the patients, as a rule, call for the assistance of a physician at a very early period. Do we have any very sanguine hopes of a patient who has suffered for years from decided catarrh of the lungs or bladder? Do you not consider yourselves fortunate when you maintain the *status in quo* in such cases? There are cases enough where, in spite of the greatest care and the most favorable circumstances for treatment, we are not able to prevent a further advance of the disease. The older the patient, the longer

the catarrh has existed, and the more changes that have already taken place in the cavity of the tympanum, the less, of course, are we able to improve the condition of things. Yet, in some cases which promise very little at the outset, we may be able to accomplish considerable by a long continued local treatment.

The prognosis of aural catrrrh is not among the worst as compared with that of other diseases, because in by far the greater number of cases, if the condition of the patient be not too unfavorable, we may check the progress of the affection, and obviate the evil influences of relapses. In recent cases, and those that are not very old, we may very often improve the condition very much.

The prognosis will be a much more favorable one when, as time goes on, the recent instead of the old cases become the subject of medical treatment. You must do your part, gentlemen, in order that this state of things may be improved. In addition to the fact of the slightness of the subjective symptoms that are generally produced by chronic aural catarrh, there is a deficiency in the number of physicians who are willing to treat an ear case, both of which circumstances cause patients to allow an affection of the organ of hearing to advance to a great extent before assistance is sought. When the laity once know that affections of the ear in their incipiency, are recovered from, at least as rapidly as other affections, but that when they have existed for some time they are as little amenable to treatment as other diseases, and when there are physicians enough who know how to examine an incipient aural affection, and how to use the Eustachian catheter in its treatment, the prognosis of catarrh of the ear will be quite different from that which it now is.

In classifying the prognosis of the various forms of this disease, I would say, that according to my experience those classes are by far the most unfavorable where the

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changes in the membrana tympani are diffuse, and it appears thicker throughout all its layers, without any considerable change in its color or surface.

In such cases, where we seem to have a kind of sclerosis of the mucous membrane of the cavity of the tympanum that has been going on for years, we will be fortunate if we succeed so far as to diminish the tinnitus aurium. Such cases do not generally come under medical observation until loss of elasticity on the fenestræ of the labyrinth, or perhaps secondary changes in the labyrinth have occurred. We are then not infrequently unable to check the process, or preserve the patient from complete deafness.

On the other hand, the prognosis in true catarrh of the Eustachian tube is, on the whole, favorable, if it be not very old, and if no secondary changes have occurred on the fenestræ, and in the labyrinth. By opening the tube, whether it be by the catheter, or Politzer's method, the condition is momentarily improved, and we are able, by a proper treatment of the pharyngeal affection, and regular opening of the tube, to obtain a very satisfactory and even good condition of the ear. Of course occasional relapses will occur, but their evil consequences may be prevented by an early local treatment.

The prognosis is much more uncertain in true catarrh of the cavity of the tympanum.

It is very unpleasant, both for patients and physician, that we are not able to indicate in advance, with any sort of certainty, those cases which have a relatively favorable, and those that have an absolutely unfavorable prognosis.

We shall see subsequently how much the testing of the conduction of sound through the bones, as tested by the watch and tuning fork, may avail in a diagnostic and prognostic way.

The words of Schwartze[1] on this point are: "There remains nothing but the test by treatment. If a local treatment, persisted in carefully and rationally for a period of from eight to fourteen days, has no effect, either upon the hearing or the unpleasant sensations of the patient, any further treatment will probably be of no avail." I remember some cases, however, where treatment did not lead to any result until it had been persisted in for some time. I also remember cases where no improvement resulted until after long-continued local treatment, especially when the patient had used Politzer's apparatus for some time at home.

Politzer ascribes an especial significance to the existence of tinnitus aurium in making a prognosis. "Continuous subjective sounds in the ear render the prognosis unfavorable, and if in a case of chronic catarrh of the cavity of the tympanum, with constant tinnitus, a decided improvement of the hearing suddenly occurs, without any change in the subjective noise being made by the treatment, we may with great probability believe that the result of the treatment will not be permanent, but that sooner or later a relapse, or lessening of the hearing distance, will occur. Not less unfavorable is the prognosis in those cases when the affection of the ear begins with a slight tinnitus, but which gradually and slowly increases with time, until it is only till years after, that the loss of hearing has become so great that conversation near at hand is heard with difficulty. Here, also, treatment will cause very little or no improvement in the hearing."

If the appearance of the membrana tympani indicates partial and circumscribed morbid changes, especially of an adhesive nature, if it is of a whitish color, the result of treatment is often more favorable than the other con-

[1] Prakt. Beiträge zur Ohrenheilkunde, 1804, s. 24. Wiener Mediz Zeitung, 1865, Nos. 67-72.

ditions, that is, the age and general condition of the patient, duration and degree of the affection would indicate at the first glance.

When large synechiæ exist, however, which cause an entire, or nearly entire, obliteration of the cavity of the tympanum, I have scarcely ever seen any considerable improvement.

I have several times attempted, in such cases, to draw the air from the auditory canal, that is, to rarefy it by means of a bit of india rubber tubing placed air tight in the meatus. I have also combined this with a pressure from within, by sending in a gentle current of air at the same time through the Eustachian tube. There was considerable effect, but it was not permanent. In the East a much esteemed popular remedy for deafness is said to be the following: A reed is placed air tight in the ear, and sucked upon until the blood flows out in a full stream.

Cases where the deafness is very great, if there are large spots of calcareous degeneration in the membrana tympani at the same time, are, as a rule, very unfavorable for treatment. These degenerations are generally connected with morbid processes on the fenestra rotunda, or ovalis.

An impairment of hearing which has not existed very long, even if of a high degree, and one that is still becoming worse, always promise a much better result from treatment than those cases of impaired hearing that began years ago, and especially those that have remained at about the same point for years.

In the former class of cases we should always exercise due caution in speaking of the amount of improvement that may be expected from treatment. As yet we are not able to say with certainty to what extent, and of what character are the changes that may have occurred on the most important, and, unfortunately, most inaccessible parts of the cavity of the tympanum, for instance, on the

[illegible] ADHESIONS.

[illegible] determine how much pur[illegible] [illegible] have taken in the world [illegible]

[illegible] belonging to the [illegible] [illegible] asserted is [illegible] [illegible] was [illegible] [illegible] [illegible]

tive; patient could hear the sound of loud speaking near the ear, but he could distinguish nothing clearly; he could hear the whistle of a locomotive, and the noise of the cars when riding in a train; by the aid of a speaking trumpet he could carry on a conversation; his general health is improving, although he is still feeble. *Dr. Hildreth's* diagnosis was *anchylosis of the stapes, with sub-acute inflammation of the cavities of the tympanum.*

The patient returned home, and June 1st, 1863, resumed treatment. He took a preparation of iodine for six weeks. Counter irritation was kept up on mastoid process by means of nitric acid. Eleven days after, a purulent discharge occurred from each ear, which lasted four weeks in the right ear, but several months in the left.

Patient improved a very little until February, 1863, not being yet able to hear conversation without the tube, when he was engaged in shooting at a target with a musket. The gun of a comrade was loaded with nearly a double cartridge. Patient was obliged to fire the gun himself or expose the intended trick. The shock of the explosion was very great. Simultaneous with the report of the gun, loud crackling sounds were heard in the ears. There was also a great deal of pain experienced. The patient slept soundly for four or five hours after taking an anodyne. On awaking the General found that he could hear without the tube, with close attention to the speaker. The general health and hearing continued to improve. There was some nausea after the concussion just described, as well as dizziness.

The patient was again examined by *Dr. Hildreth* in March, 1863. He could then hear a watch eleven inches from the right auricle, and nine from the left. There was a slight purulent discharge from the right auditory canal. The patient believes that the discharge from the ear, in 1860, was due to boils in the meatus. He continued in service until 1865, when he was mustered out, the war having ended.

In December, 1867, the patient wrote to a patient of the editor as follows: "My hearing is not dull enough to cause any inconvenience, except when the ears are obstructed by boils."

The above case seems to be one of rupture of adhesions in the cavity of the tympanum, from the concussion described. The sudden improvement to the hearing can hardly be attributed to any other cause. St. J. R.)

LECTURE XXI.

TREATMENT OF CHRONIC CATARRH OF THE EAR.

Local treatment of the ear; air bath or douche; vapors and gases; mechanical methods of dilatation; agents acting upon the outer surface of the membrana tympani; carbonic acid, compressed air, etc.; treatment of the mucous membrane of the pharynx; cauterization; gargling, and its mechanical importance; pharyngeal and nasal douche; posterior nares syringe; excision of the tonsils and uvula; consideration of the patient's general condition.

GENTLEMEN: Since we have studied the nature of aural catarrh in all its variations, we may close the subject to-day with some remarks on the treatment of the disease. This should consist in a correction of the altered condition of the mucous membrane of the ear, nose and pharynx, and in an attention to the general health of the patient. In most cases it is not sufficient to attend to one of these points, but they must all be regarded.

The strictly local treatment consists chiefly in the frequent use of the air bath or douche. By this means the tube again becomes permeable; any difference of the pressure of air in the cavity of the tympanum, or pharyngeal space, is equalized, and at the same time a mechanical pressure is exerted upon the elastic walls of the cavity of the tympanum, that is, upon the membrana tympani and membranes of the fenestræ. This pressure stretches and

relaxes these parts, counteracts any incipient rigidity and want of elasticity, and besides it may loosen abnormal adhesions.

For the purpose of giving the air bath we may use the Eustachian catheter, into which air is forced, either with the mouth or an india-rubber air bag (see cut, p. 208), or, in case of necessity, by means of a compression pump. In slight cases, and where simple closure of the tube exists, Politzer's method alone may be employed. When the tube has once been opened, it is advisable to recommend the patient to keep it permeable by the regular employment of the Valsalvian experiment.

(I have grown very cautious in recommending the employment of the Valsalvian experiment, since I have seen that several persons who have been in the habit of employing it for years, have thereby induced such a relaxed condition of the membrana tympani that it will not remain pressed out for more than a minute or two. It has been employed in these cases without the use of the catheter or Politzer's method, and when they come to be employed at a subsequent period, no effect is produced upon the patient. This is especially the case in the use of the latter named means of inflating the drum. St. J. R.)

This purely mechanical effect of the air douche is not infrequently sufficient of itself, in recent cases, especially those occurring in children, and in pure tubal catarrh. Its employment is also necessary in the beginning of the treatment of all cases, in order to make a free passage to the ear.

In all cases that are not very recent, or which are not very slight affections, the abnormally secreting, swollen, or already thickened mucous membrane of the tube, or of the cavity of the tympanum, must also be acted upon. This is achieved by means of the injection of vapors or medicated fluids through the catheter.

The use of vapors or gases.—As long as there is a rattling sound in the use of the air bath, and we may believe that there is an increase of secretion, and a moist swelling of the whole mucous tract, the vapor of the muriate of ammonia is of particular value, just as its inhalation is now successfully practiced in laryngeal and bronchial catarrh.

Formerly I heated the powdered muriate, and blew the white vapor of the sublimated salt into the ear. The vapor is less irritating, however, and acts more favorably if blown in while in the process of being generated. For this purpose we need an apparatus consisting of three glass bottles connected with each other by tubes. One of these flasks is filled with *liquor ammonia caustici;* the other with *hydro-chloric acid.* They empty, by means of a glass tube, into the third, containing some hydrochloric acid mixed with water. If, now, air is blown with the mouth or the rubber bag, into the two first named fluids, by means of a double tube joined posteriorly, ammonia and hydrochloric acid vapor are developed, which unite, under water in the third flask, to ammonia, rapidly fill this, and may be driven into the catheter through a glass tube opening under water, to which an india-rubber tube is attached. (See cut on page 228.)

The amount of pain from this procedure (or of unpleasant sensation, it is scarcely a pain. St. J. R.) is very different in different cases. Some patients complain only of an unpleasant sensation of heat, others of a biting sensation. Others, again, complain of severe pain, but which is only of very short duration, partly in the ear and partly in the throat.

If the patient says he only feels the vapor in his throat, we need not always conclude that it has not passed into the ear. The otoscope (or diagnostic tube), and the subsequent examinations of the membrana tympani, when

the vessels on the handle of the malleus are generally found to be injected, after the application of the chloride of ammonium, tell, generally, a plainer and more correct story than the patient. Generally speaking, I use the vapor daily for some time, consuming several minutes at each application. It is well to blow in simple air occasionally during the sittings. By doing this we make the tube pervious more quickly, and more accessible to the vapor. We cannot lay down any rule as to how long each sitting may require to be in all cases, or whether each ear is to be acted upon daily, or oftener. All this will depend upon the effect of the vapor. Generally the secretion is soon checked, the impermeability of the tube is removed, and a fuller and stronger stream of air passes into the ear. In older cases the ammonia serves only as a preparatory remedy, by means of which a further treatment is rendered possible.

Moist warmth is the most powerful softening agent and aid to resorption. On this account the vapor of warm water has long been used in treating thickening of the mucous membrane of the middle ear. We choose a high or low temperature for the vapor, according to circumstances. I generally use from 35° to 45° Reaumer (Fahrenheit, 110° to 133°). The warmer it is applied, the oftener we must allow pauses during the application, in order that the silver of the catheter may not be overheated, and thus cause an unpleasant burning sensation in the nose. The heat of the catheter is felt mostly at the nasal entrance, and I take care, in cases where I must use a high degree of heat, say 50° to 60° R., or where the patient is peculiarly sensitive, to guard the part by means of a piece of gutta percha, which is drawn around the beak of the catheter before its introduction. The effect of the warmth is very much less marked in the pharyngeal entrance to the tube, and in the cavity of the tympanum itself. The duration of a sitting, during which the vapor

is forced in, sometimes in an interrupted, again a continuous stream, varies from five to ten minutes, or longer.

I have made various experiments in chronic cases, with different kinds of vapors, and when I, perhaps, except iodine and acetic ether, I must choose vapor of water as the best. Among the preparations which I have used, are, besides the different varieties of ether, chloroform, acetic acid, aceton (one of the products of the dry distillation of wood), acidum pyrolignosum, ol. terebinth, both alone and in combination with the narcotic extracts, such as extract of hyoscyamus, which is said to be of particular value in subduing tinnitus, and all without any especial benefit.

We should not cease, however, to attempt to find new remedies, some one or other of which may be of great use in a particular case. The effects of remedies on a mucous membrane can only be made known through a series of observations and experiments. I should mention the vapor of carbonate of ammonia, of course without any addition of water, as another of the remedies which I have used. It is more irritating than the muriate of ammonia. This is also true of calomel and camphor, which has an almost indifferent effect. I have also used carbonic acid gas; we may use this mixed with atmospheric air, or with vapor of warm water.

Ruete first advised the use of carbonic acid gas. I prepare this gas in a narrow necked flask, from broken bits of stone found in this vicinity, and dilute hydrochloric acid. The stopper of the flask has three holes, one containing a long glass funnel for the gradual addition of the acid, and the other two containing two glass tubes, bent almost at a right angle, which are connected to the pump and the catheter in the manner before described The use of chalk instead of the stones, causes too sudden and violent generation of the gas. On the whole, it seems to me a very weak, and consequently inefficacious irritant

Besides, the use of such a vapor for a long time may have an injurious effect upon the lungs.

Of course all these applications must be made with a certain *vis a tergo*, that is, a compression pump, or the like, must be used if we would be certain that the air passes not only into the lower part of the tube, but also into the cavity of the tympanum itself. It is always advisable to occasionally introduce a diagnostic tube during the use of the catheter, in order to assure ourselves that the instrument has not been displaced. This precaution is doubly necessary when we cannot fully rely on the intelligence of the patient who is holding the catheter. The vapor will much more certainly reach the upper part of the middle ear if we force it in at intervals, and not in an uninterrupted current.

The injection of fluids through the catheter. — This is much simpler than the use of vapors, since all the apparatus that is necessary is a small glass tube (*pipette*), for obtaining the required amount of fluid from the bottle in which it may be contained, and for its subsequent blowing into the catheter.

If the patient be made to swallow while a powerful current of air is driven through the catheter by means of the India-rubber bag, and the instrument be in the correct position, although the tube need not fully enclose its beak, a portion of the fluid in the catheter will be driven into the cavity of the tympanum, even if more than that which enters this space, runs into the pharynx or the mastoid process.

Among the substances which may thus be injected into the middle ear, I may especially mention, as of particular value, solutions of sulphate of zinc (one to ten grains to the ounce of distilled water), chloride of ammonium (ten to forty grains), liquor potassæ (four to forty drops), iodide

of potassium (ten to sixty grains), iodine in a solution of iodide of potassium (one to six grains to a scruple of iodide of potassium). These quantities are each to be added to an ounce of water, like the one first mentioned. Glycerine may also be used in a pure state, or mixed with an equal amount of water, or added to any one of the above-named solutions.

I have also made experiments with solutions of alum, carbonate of soda, dilute acetic, and hydrochloric acid. The latter is sometimes very efficacious, since it generally increases the secretion of the mucous membrane of the tube in a very marked manner.

The effect of all these agents, if used in a concentrated form, when we except glycerine, which tends to make the parts more pliable, is an irritating one. The vascularity is temporarily increased, and thus, possibly relaxation is induced, or an absorbent process may be set up in the hypertrophied and thickened mucous tissue. In weak solutions alum and zinc are of course only astringents. There is also a disintegrating chemical effect to be ascribed to the ammonia and the acids.

Experience has shown that the same benefits may be obtained by the injection of irritating fluids, as with the use of the vapor of water. Both of these means of medication act in about the same manner upon a mucous membrane affected with chronic catarrh. There is a considerable advantage in the use of the injections over that of the steam, with or without the addition of irritating substances, especially in cases where the tube is naturally narrow, and consequently less of the vapor enters the cavity of the tympanum, because the vapor of itself moistens and swells the tube. The injections are also more useful if the vapors have an unpleasant effect upon the mucous membrane of the nose and pharynx, these parts always being in contact with the gases employed.

In the use of the vapor of muriate of ammonia, we often have very good results from this very contact, while the vapor of water, especially that with the addition of iodine, very often makes the condition of the mucous membrane of the pharynx worse. We should also not overlook the fact that not an inconsiderable portion of the vapor is breathed into the lungs.

If we now look at the dark side of the use of the injection of fluids, we find the following disadvantages: The beak of the catheter must rest between the lips of the tube, and not merely in front of its orifice, and also be in the same direction with the course of the tube, or all the fluid will run into the throat. We must, therefore, use catheters having a large curvature. Their employment requires more skill than the ordinary ones. Besides, we require a certain assistance of the patient. If he does not swallow at the same time that the fluid is driven in, we may often fail in injecting the cavity of the tympanum.

But in the most favorable cases a portion of the fluid must run into the pharynx, because the stream issuing from the catheter divides up, or is larger than the caliber of the isthmus of the tube, so that only the central portion can pass through, while the other part must flow downward. It is but seldom that all the fluid passed into the ear and none at all into the throat. In individual cases we can decide by auscultating the ear at the same time that the injection is made, whether a portion of the fluid actually entered the middle ear. The patient is generally, also, able to judge correctly as to this point.

Subsequent examination of the membrana tympani, after the use of the more irritating materials generally shows more or less redness of its surface, just as is seen after the use of irritating vapors, or Politzer's air bag.

We cannot decide in advance, just how many drops will enter the cavity of the tympanum. When the stream

driven in is a very vigorous one, some drops may pass through the cavity of the tympanum into the cells of the mastoid process. They lie at the same hight with the entrance of the tube, and just opposite to it. In some cases a further unpleasant result may be, that all the fluid which enters may run off the smooth walls of the cavity, and finally collect on the floor, and thus produce too strong an effect on some parts.

It will be found best to use only a few drops at each injection, repeating the operation several times. If the patient does not succeed in swallowing exactly at the desired moment, he may take a little water in the mouth in order to facilitate this action. At the moment of injecting the fluid, the beak of the catheter should be pushed somewhat forward in the direction of the tube.

Not unfrequently very good results are achieved by a combination of the two methods. After a use of the warm vapor of water, an injection of an irritating fluid may be employed. In this way the mucous membrane is first moistened and relaxed, and thus the fluid more readily and thoroughly taken up. Even in cases where there is no contrary indication to the long-continued use of moist warmth, it is well to interrupt the treatment for days at a time, and in the interim employ the simple air douche, the vapor of muriate ammonia, or astringent injections. The injections should be only rarely employed once a day. Every two to three days will be usually found sufficient.

(A very convenient method of using the injection is to place the fluid which we wish to inject in the beak of the catheter, by means of a small Anel's syringe or the like, and then stop up the outer end with a tightly fitting cork. The catheter may then be introduced without spilling any of the fluid, and its more certain entrance into the cavity of the tympanum will be favored. St. J. R.)

You will sometimes observe, after a long-continued use of steam, to which an irritating substance, such as the tincture of iodine, has been added, or after irritating injections, that considerable relaxation and vascular injection have been produced on the mucous membrane, so that the patient at first hears worse, and his head seems to be full and heavy, while the tube is not so permeable, and he complains that the tinnitus has been increased.

Some of the substances before named, if used in strong solutions, very frequently excite severe pain. It is very seldom that such pain lasts, at the greatest, more than a few hours. I would prefer that such symptoms of hyperæmia and swelling in the ear appear, than that the vigorous medication should have no effect upon it at all. It is always well to cause the patient to force the air into his ears several times during the day, either by means of the Valsalvian experiment, or by Politzer's method, and at each application of the vapor or injections we should assure ourselves of the permeability of the tube by means of the simple air douche.

Acting upon a repeated experience, that patients with chronic catarrh have attained very marked results from treatment, where they had been accidentally affected with an acute inflammation of the middle ear, I have endeavored in several cases to artificially excite an acute catarrh. I used for this purpose very irritating vapor, such as pure tincture of iodine, or concentrated acetic acid, which I forced into the cavity of the tympanum in a strong current. The pain and other symptoms occurring from this treatment, were generally severe, but I have never obtained a result proportionate to such a severe procedure, or even any kind of improvement in the hearing power.

If we look at the changes that the post mortem section shows in patients with chronic catarrh, we may be able to estimate the results to be reasonably expected from

treatment. If, for example, the whole canal leading to the *membrana fenestra rotunda* is unfortunately filled with a plug of connective tissue, as has often been found and described, or the membrane itself is very much thickened, inelastic, and rigid, or changed to a thin, calcareous plate, or if the stapes be enveloped in a rigid mass of connective tissue, and its base firmly united (anclylosed) to the surrounding bony tissue, I would ask if we may expect any result from any treatment but one that is purely operative.

I am firmly convinced that in the practice of aural surgery there will yet be a wider field for operative interference. The present position of the science is, however, not sufficiently advanced to justify experiments in such a direction. Every step forward must be made with great care, and operations should only be performed after repeated experiments upon the dead body and upon animals.

There is no department of our art where there is so much practice that is simply ridiculous, as in aural medicine and surgery. Nowhere is such unscientific shuffling allowed and honored, as that which is sometimes seen here. Nowhere do we meet such a want of confidence on the part of both the laity and physicians as to what medical skill can do. He, then, who is in earnest with this matter of treating diseases of the ear, must avoid every appearance of the evil which has gathered about this part of our profession, and which has brought it into disrepute. Even in that most advanced of all special departments, opthalmology, many operations are unsuccessful, even when performed by the most eminent of the profession, with the most correct indications, and with great skill in execution. In the worst cases the patient loses his eye; from an operation in the deeper parts of the ear, on the contrary, something of much more value, the life, is put in jeopardy.

(It has been lately proposed to remove the incus from the chain of bones, in obstinate and severe cases of chronic catarrh (sclerosis), with great tinnitus aurium. The operation has been performed several times, but the results, except that no permanent harm has resulted, are not known to the editor. The malleus is also removed by Dr. Wreden of St. Petersburg.[1] St. J. R.)

Mechanical dilatation of the Eustachian tube.—In cases where, in spite of the frequent use of the air douche, of the vapor of the muriate of ammonia, and astringent injections, the stream of air enters the ear in a feeble manner, or only with the assistance of the act of swallowing, in other words, in cases where the great narrowing of the tube does not depend upon hyperæmic swelling of the mucous membrane, but on an organized hypertrophy of the connective tissue, and we are dealing with a sort of cicatritial stricture, there remains nothing to be done but to enter the tube by means of bougies, and thus to gradually enlarge the canal. I generally use cat-gut bougies for this purpose, more rarely probes of whalebone. *Schwartze* recommends bougies made of *laminaria digitata; Guye*, of Amsterdam, those made of parchment.

All these bougies should have a blunt, conical extremity. The length of the catheter through which they are to be introduced, should be inscribed upon them, as well as the length of the cartilaginous portion, 24 mm., and of the osseous, 11 mm. It is well to use a catheter with a large curve, and to press it very much on the nasal septum, in order that the beak may pass as far as possible between the lips of the pharyngeal orifice.

As soon as the probe reaches the middle of the tube, the patient speaks of a painful sensation in the ear. When it reaches the last third, the point of transition of the

[1] Monatsschrift für Ohrenheilkunde, Vol. 1, No. 17.

cartilaginous into the osseous tube, where the canal is the narrowest, the local pain increases very considerably, and is often referred to the upper and lower teeth. One patient always complained of a pain in the back part of his head.

If the probe will not pass any further on, we may sometimes succeed in causing it to advance by drawing it back a little, or by turning it on its axis. It is interesting to notice the very distinct movement of the bougie when the patient swallows. Sometimes it may be seen through the membrana tympani, a little above the center of the anterior half.

In the most cases the appearance of the bougie on withdrawal, corresponds to the peculiar spiral course of the tube. Not infrequently, even when the introduction is performed with exceeding care, the bougie is found somewhat tinged with blood.

The maximal diameter of the narrowest portion of the tube, the *isthmus tubæ*, in adults is from 1½ to 2 m. The largest bougies to be used cannot, therefore, be thicker than this. Where, on account of an abnormal width of the tube, thicker probes may be passed, there is no indication for their employment. Probes of whalebone may be made gradually thicker after the first inch, which will greatly increase their power of resistance. In cases where the obstruction in the tube was very great, I have been enabled to make a passage with such a probe, when I had failed with a cat-gut one of a less or the same thickness. The latter are, of course, more flexible and yielding, but bend more on this account.

We should begin with the smallest sizes, and pass on gradually to larger ones. I have observed emphysema of the neck, as have others, several times, after the use of the probes.

In order to avoid this we cause the patient to force air

into his ears just before and after the probing. Some pain in swallowing is apt to remain for a few hours. After a few probings the current of air, as well as the probes, pass through much more freely.

Rau recommends the use of cat-gut bougies saturated with a solution of nitrate of silver, in order to unite dilatation with cauterization. I have seen in some cases, after the introduction of bougies thus prepared, excessive pain in the ear, with perforation of the membrana tympani. This may occur, however, after the use of the simple cat-gut bougies, and when they have been introduced with no great difficulty.

On the whole, these attempts to mechanically dilate the tube are not very frequently necessary, although there are cases which cannot be satisfactorily treated without them. Very recently this method of treatment has been abused, and probes have been used with a frequency that can not be at all justified.

Agents acting upon the external auditory canal and the outer surface of the membrana tympani.—I have never found these useful in cases of chronic catarrh, when used alone. I have never seen any benefit from the use of a stream of carbonic acid gas, which is allowed to pass into the ear, and which is so frequently advised at the mineral springs in Germany. It even being doubtful to me if the gas can pass freely through a thickened membrana tympani, if a moderate amount of pressure be exerted.

Compressed air, or the pneumatic cabinet.—This is a means of treatment which has been lately introduced for the treatment of all sorts of diseases, and especially for "catarrhal deafness."

I have seen numerous patients who have been treated by this apparatus, and I have never seen any permanent result from it which might not be attained in a much more certain and exact way, by rendering the Eustachian tube pervious. I may therefore coincide with the views of *Magnus*,[1] who, at the close of his article on "the condition of the ear in compressed air,"[1] says: "For this means of treatment where slight degrees of pressure are employed, much simpler means may be substituted, viz., the Valsalvian experiment, Politzer's method of inflating the ear, and the catheter. In the employment of greater pressure there is considerable danger that cannot be overestimated.

Toynbee very warmly recommends pencilling the auditory canal and the membrana tympani with a weak solution of nitrate of silver. I considered it my duty to employ this method of treatment, but I have never seen any result from its use except that the pencilled parts became black. Iodine in solution, or in the form of an ointment, may be rubbed behind the ear as an adjunct in the treatment.

Very recently *Politzer* has recommended for cases where, in consequence of the great inclination of the extremity of the handle of the malleus inwards, we may conclude that there has been a shortening of the tendon of the tensor tympani, that the external auditory canal be hermetically closed for twenty-four hours by a plug of cloth saturated with fat. This remedy is used not only for the improvement of the hearing, but also for the diminution of the tinnitus. *Politzer* believes that in this way, he diminishes the effect of the external atmospheric pressure upon the drum, and causes a resorption and thinning of the air between the membrana tympani and the plug. He has shown by experiment that the air in the external audi-

[1] Archiv für Ohrenheilkunde, I 4, s. 283.

tory canal is rarefied by the hermetical closure of the passage.

Counter irritation.—The benefits from blisters behind the ear, which have been until lately almost universally recommended in chronic affections of the organ, are quite doubtful. Certainly, unless combined with local treatment, they do no good whatever.

(If they are to be used at all in chronic catarrh, they should be employed for a great length of time, say from six weeks to two months. I have had the opportunity of watching many chronic cases where an irritation of the mastoid process has been kept up for months, and never have I seen any other result than that a great annoyance was caused the patient. In sub-acute cases I believe blisters to be an efficient adjunct. St. J. R.)

Application of remedial agents to the pharynx.—We may now, gentlemen, go on to consider that which must never be neglected—the treatment of the mucous membrane of the pharynx. Even in cases where no improvement is to be expected, we may by this means most frequently prevent the further progress of the affection. Nothing will do so much to maintain a chronic hyperæmia of the mucous membrane of the ear, as an old congested condition of the same membrane of the pharynx left to itself.

Cauterization.—Cauterizations of the affected membrane do excellently well. The solid stick is better adapted for granulations, or where there is very intense general swelling. But even in the latter mentioned cases we should not cauterize too large a space at once, lest there be trouble in swallowing, and the effect on the larynx and trachea be too great. We should content ourselves

with touching one or two spots, especially on the side of the pharynx, where the red swellings already described extend downward from the Eustachian tubes. In order to be able to touch the upper part of the pharynx with the caustic, I use a caustic holder, such as is used in cauterizing strictures of the uretha, being a tube at the end of a strong silver wire, opening laterally. This is introduced through an Eustachian catheter. It is especially useful for circumscribed swellings, such as are often seen near the entrance of the Eustachian tube.

I would generally, however, advise you to use *solutions* of nitrate of silver, of a strength of from twenty to fifty, and even sixty grains to the ounce of water. For the lower portion of the pharynx, that opening into the mouth, a camel's hair pencil is best adapted for conveying the solution; and, for other parts, a whalebone with a piece of sponge attached, bending the bone according to the part we wish to touch, and thus we are able, while the patient takes a long breath, not only to reach the part near the tube, but also even to the base of the skull, if we are careful.

The irritation of such a cauterization of the upper part of the pharynx is very different in different cases. The pain caused is seldom of very long duration, and is most marked in swallowing. A considerable mucous secretion very often results, or an increased flow of saliva; sometimes severe fits of sneezing occur, very rarely nasal hemorrhage. For a little time small quantities of blood are mingled with the expectorated matter. In a case where the sponge had been directed very much towards the mouth of the tube, a marked increase in the impairment of hearing was noticed for some hours after, caused by an increased congestive swelling of the mucous membrane. It is seldom necessary to use a gargle of cold water after such a cauterization.

The change in the pharyngeal membrane after cauterization, occurs very rapidly, sometimes after one or two applications. It is to be performed daily, or at longer intervals, according to circumstances. Recently I have been in the habit of pencilling the naso-pharyngeal space with a fine, long camel's hair brush dipped in a solution of nitrate of silver, and introduced through the nose. I can very warmly recommend this method in those cases where the tissue on the turbinated bones, and in the vicinity of the mouths of the tubes, is greatly swelled. I sometimes, though not often, pencil the pharynx with iodine and glycerine, and liq. ferri sesquichlorati, pure or diluted, or apply pulverized alum to isolated parts.

Gargles.—Gargling is of great benefit to the membrane. The gargles may be made of cold water or mixtures may be used. I make them more commonly from alum or iodine.

℞.
Alum pulv. ʒi.—ʒij.
Aq. destillat. ℥viij.
Spts. vin. gall. ʒi.—ʒiij.
M.

The addition of brandy covers the astringent, unpleasant taste of the alum, while common honey and sugar mixtures are only unpleasanter for many patients.

Gargles of iodine are peculiarly adapted for children, and for cases where there is a severe swelling of the glandular portions of the mucous membrane.

℞.
Tr. iod. ♈i.
Potass. iodid. ♈ij. ad ʒii.
Spts. vin. gall. ʒi.—ʒiij.
Aq. destillat. ℥viij.
M.

These iodine gargles have more than a local effect on the parts. I have seen goitre considerably decreased in

size by their use, and ladies have called my attention to a growing smaller of the form, a slight decrease in size of the breasts from the same cause.

In cases where secondary syphilis manifests itself in the form of ulcers on the soft palate, on the tonsils, and on the edge of the tongue, in the form of pustules, or ulcerations, the tincture of iodine gargle, and also one of hydrag. bichlorid. gr. i-iij. ad aqua ℥viij., will be found beneficial. Besides these, there are a variety of preparations which may be used with advantage.

According to my view, gargles, in connection with the immediate effect of their component parts upon the structures with which they come in contact, have another and perhaps essential effect, apart from the act of gargling itself.

It is interesting to know that *Celsus* recommended gargles in affections of the ear. It is not certain that he knew of the existence of the tube, although it had been distinctly described before his time.

If we examine the structure of the mucous membrane we will not only be convinced that the layer richest in mucous glands lies over the muscular fibers. This shows that these glands must be greatly affected by each muscular contraction, and that in many places, especially in the soft palate, the arrangement of the muscular fiber is such that it passes around, envelopes, and grasps many of the glands. Every energetic contraction of the muscle, then, must make a certain pressure on the glands, and a vigorous swallowing motion will assist greatly in ejecting their contents; the mouths of the glands being quite patulous, especially on the uvula, and anterior surface of the soft palate.

Gargles, in order to do any good, must be used properly. As generally employed, the patient standing with the head thrown backward, and moving the gargle about with the well known roaring sound, no parts beyond the

teeth, the dorsum of the tongue, with the uvula, and the most prominent portions of the tonsils, are touched by the gargle. The whole muscular action consists of a strong to and fro motion of the uvula. In such a kind of gargling there can be no such thing as contact with the posterior pharyngeal wall, or an energetic muscular contraction.

Gargling must be practiced in a different manner in order to accomplish this latter object. Let the patient sit, or, better, lie down, with the head thrown back as far as possible, and, taking the gargle in the mouth, continue to make repeated swallowing motions, without, however, admitting the fluid into the œsophagus. Try this method of gargling, with simple water, in your own persons, and you will convince yourselves, by the sensation experienced, that many more parts are brought in contact than by the noisy method, commonly practiced; and you will find, furthermore, that a greater or less amount of mucus is ejected, during or immediately after the act, if the mucous membrane be in a congested condition.

Frequent gargling, if only with cold water, is an excellent remedy in chronic pharyngeal catarrh. Not only is every abnormal collection of secretion prevented, and the normal excretion favored, but a gymnastic exercise of the muscles involved in the swallowing act, also occurs. Every striated muscle increases in volume and power, by means of constant and methodical exercise, as you all may see in gymnasiums, the exercises of the turners, etc.

Now but apply this result of our general experience to the muscles of the throat, and you will see the value of such exercises, especially if you consider at the same time the importance of these muscles for the functions of the Eustachian tube, and for a normal condition of the middle ear. You remember that in chronic pharyngeal catarrh a great power is required of the muscles of the tube, a power which can only be obtained when they have been

developed in size and strength. You will see, if you recall these facts, that gargles and frequent action of the muscles used in swallowing, are the best remedies for insufficiency of the muscles of the tube, which, as we have seen, occurs very often in aural and pharyngeal catarrh.

You observe, gentlemen, that I especially esteem gargles from a mechanical, or, if you please, a gymnastic point of view. I assure you these are no theoretical and *a priori* speculations, but I have seen important results from simple gargling with cold water, when continued for a long time.

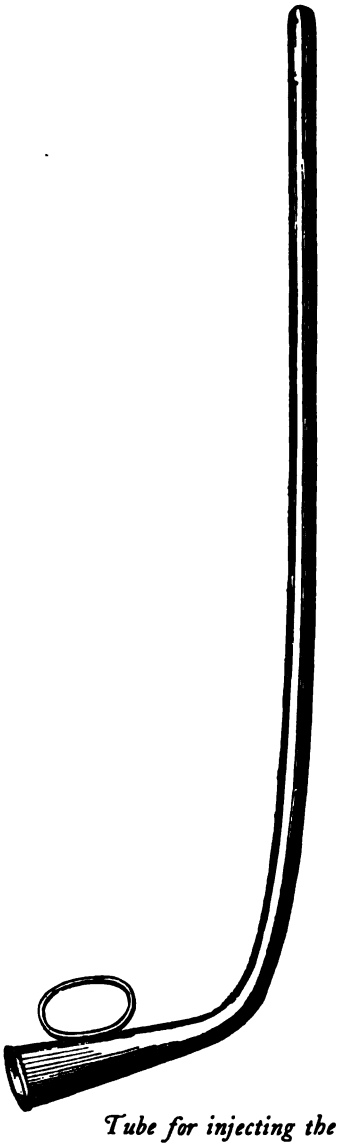
I have seen patients who have suffered from noises in the ear, and difficulty in swallowing, from long-continued pharyngeal and aural catarrh, who, with the slightest cold, have pain in the throat, and increased secretion in the fauces, and thus add to their loss of hearing, who awake every morning with a burning, dry larynx, heavy head, and a fullness in the ear, and who remove the collected mucus only with much difficulty, freed, to a great degree, from all these symptoms, and become in every way better by the use of gargles, while the affection of the ear, which was steadily increasing, has also been brought to a standstill.

Gargling should be done at least twice a day—early in the morning, and just before going to bed. In many cases of chronic inflammations of the lower pharyngeal space, the patient may also use a nebulizing apparatus. Such patients may also snuff water, or a medicated solution, into the nostrils every day.

The secretion in the upper pharyngeal space is so considerable in many persons, especially around and behind the mouth of the Eustachian tube, that with almost every introduction of the catheter a mass of greenish grey mucus will be drawn out, and a loud rattling sound excited at the beginning of the passage of air. In such cases

: seen important results from repeated injections of
or luke-warm water into the nose, and they also
inish the fœtid smell from the nose and pharynx.

FIG. 31.



Tube for injecting the nostrils.

If the nose be injected with the ordinary ear syringe, the posterior and lateral wall of the pharynx will not be touched enough, and in many patients the injection causes a severe pain in the forehead, especially if the opening of the syringe be directed upward. I have, therefore, caused a silver tube to be made, of the same length with the catheter, whose end is closed, but the sides are perforated with little holes for a short distance from the extremity. By means of this instrument we are able to reach the wall of the pharynx more conveniently and safely. In order that the patient can better apply the syringe himself, the outer extremity is bent nearly to a right angle. The introduction of such a tube is easily learned, even by the least intelligent. The water will generally pass out of the nose again. Many patients have told me that the head felt much freer immediately after the injection, and that the noises in the ear were sensibly diminished, and they often speak of astonishingly large quantities of mucus which have been removed in this manner.

Weber's nasal douche.—Professor *Theodore Weber*, of Halle, has quite recently suggested a very ingenious method of cleansing the nostrils, by which the whole naso-pharyngeal cavity may be filled with fluid in a very simple manner. In Weber's method we use either a vessel, from the lowest part of which proceeds an india-rubber tube, or a syphon arrangement consisting of a perforated lead plate and a long tube, with a conical nose-piece. Weber very properly calls attention to the fact that simple water loosens the epithelium, and that it is therefore by no means an indifferent fluid to the mucous membranes. We should use a little milk with the water, or a weak solution of common salt. The patient should avoid any great inclination of his head forward, or a severe headache,

sometimes lasting for hours, may be caused. This results from the entrance of water into the frontal sinus.

(The engraving representing Dr. Clark's ear douche, on page 95, will serve to illustrate *Weber's* apparatus. It is known as *Thudichum's* apparatus, in England and America, although *Weber* was undoubtedly the one who first suggested its employment.

In order to use it, the vessel containing the water is placed a little higher than the patient's head. The nozzle is placed carefully in one nostril, and the patient opens his mouth, holding it over the vessel in which the emergent stream is to pass. If he breathes gently, the uvula will lie against the posterior wall of the pharynx, thus closing the upper space from the lower. The water will then run around the nostril into which it entered, and pass out through the other.

I have employed this nasal douche to quite an extent, but it has been so unpleasant to many patients, and so hard to manage, when the patient does not happen to be very tractable and intelligent, that I have nearly abandoned it, using instead the posterior nares syringe.

I find that the latter named instrument produces very little or no discomfort, and that from three to four syringe-fulls will thoroughly cleanse the nostrils and pharynx.

FIG. 32.

Posterior nares syringe.

Nasal nebulizer.—I am in the daily habit of using a nebulizer upon the mouth of the Eustachian tube, in naso-pharyngeal and aural catarrh, and am very much pleased with the effects. Mr. Bishop, of London, first advised

the use of these instruments in aural affections, and claim that the spray enters the cavity of the tympanum.

FIG. 33.

's nebulizer for Eustachian tube.

sketch of Mr. B.'s nebulizer is here given. It is a very awkward instrument, and I prefer one made similarly to Richardson's local anæsthesia apparatus. The tube is like that of a Eustachian catheter, and is introduced the same way. A solution of common salt, of tincture ferri sesquichlorid, chlorate of potash, or any of the agents employed on inflamed mucous membrane, may be used through the nasal or Eustachian nebulizer. St. J. R.)

Removal of the tonsils.—If the tonsils be abnormally large, they must be removed, or the treatment will have no lasting effect. Hypertrophied tonsils, if not themselves the seat of frequent inflammation and abscesses, retain the chronic congested condition of the pharynx by their presence, since they act as foreign bodies, and prevent the normal action of the muscles of the throat. They also push the broad portion of the soft palate upward, and thus, but not in a direct manner, as is generally believed, press the anterior lip of the Eustachian tube against the posterior. I have also seen improvement in the hearing in recent cases of aural catarrh, immediately after the removal of the tonsils, and in children; but even in old cases the chronic catarrh of the pharynx is very much improved, and it loses the tendency to increase the affection of the ear.

I also advise you to exercise the tonsils when they are large, even if they have not as yet had an evil effect upon the organ of hearing. Setting aside the fact that a removal will guard the ear from any evil consequences, enlarged tonsils are a hindrance in respiration, and thus have a considerable effect on the whole constitution, especially on the development of the chest. They may be excised with Fahnestock's instrument or Tonsillotome. You should remove only the portion of the tonsil which reaches out in front of the arch of the palate, since,

without this precaution, you may have severe hemorrhage, which cannot be checked. The end of the tonsil being thus cut off, the gland will afterward shrink away. Incisions and scarifications are only useful in acute cases, and in the evacuation of abscesses. Pencilling with iodine, nitrate of silver, etc., even when persisted in for weeks, according to my experience, produces no result.

(Powerful caustics may be introduced on an instrument adapted to prevent them from slipping off before reaching the part to be cauterized, and a large portion of the tonsil thus removed. The appliance used consists essentially of a spatula, containing on its extremity a receptacle for the caustic, which is opened when the surface of the tonsil is reached, by the withdrawal of a sliding cover which works from the handle of the instrument. St. J. R.)

It is at times of great advantage to cut off an elongated and hypertrophied uvula, which frequently causes very severe attacks of coughing, occurring at night especially. We may draw it forward with a polypus forceps, which acts at the same time as a spatula, and cut it off with a pair of scissors.

The general condition of the patient.—In considering this, I may remark, gentlemen, that if I were to go into the greatest detail of description, I should not be able to enumerate all that we are required to consider in a case of chronic catarrh, but I will be very brief in what I have to say, trusting that you will carefully consider each case by itself.

Make each patient attentive to every influence which acts favorably or unfavorably on his condition. If a person works for a whole day with a bended head, in an overheated office or counting room, perhaps never enjoying more than half an hour's fresh air in a week, in the evening smokes and drinks in a reeking restaurant or bar-

room, and sleeps in a small, unventilated chamber until very late in the morning, he has very many opportunities to develop an aural and pharyngeal catarrh to its utmost, and you will never be able to lessen the disease, whatever you may do. Fresh air, and exercise in it, but with an avoidance of cold mornings and evenings, clothing adapted to the weather, woolen or silk next to the body in winter, care that the feet are dry and warm, an avoidance of whatever interferes with the free circulation of the blood, viz., tight articles of dress, costive bowels, and long-continued sitting in a bent position, are very important matters in this class of cases.

Treatment by the so-called "whey cure," the "grape treatment," and the use of mineral waters, is often of great value in chronic catarrh, especially after, and in connection with, local treatment. Without the latter we can never stop the steady progress of the disease. The most energetic treatment by baths and drinking of mineral waters, cannot be remotely compared to the local treatment. The use of salt baths is most frequently indicated.

Of internal remedies, cod-liver oil, especially with an addition of oil of turpentine, seems to lessen the tendency to catarrh the most; a half to one scruple of turpentine may be used to an ounce of the oil. We may somewhat disguise the taste by the addition of a little oil of cinnamon or sassafras.

Of course where there is a decided syphilitic or scrofulous basis in an affection of the ear, the constitutional disease should be appropriately treated. Yet in these cases the local treatment should never be neglected.

It is very important, in the management of aural and pharyngeal catarrh, to take good care of the skin. In the cold weather a warm bath should be taken quite often. It is better that baths in this season should be taken in the patient's own house, in order to avoid taking cold after them. In the summer the patient may bathe in cold run-

ning water, taking care that the ears are protected from the entrance of the water. The body should be well rubbed after bathing.

(Too frequent and prolonged bathing is a common cause of tubal catarrh in young persons. I have seen so many little patients who have become deaf after excessive bathing, that I am in the habit of warning parents from allowing the prolonged bathing and "ducking the head," so common among boys. St. J. R.)

Up to this time I have observed that patients have often become worse after the use of sea baths, but I have seen a residence on the sea coast, with use of warm sea water baths in doors, do great service, especially in young and torpid individuals.

There are some patients upon whom baths, when taken in the morning, act unpleasantly, that is, excite trouble in the ears.

Although the hydropathic or water cure treatment, conducted properly, especially the cold rubbings, may be able to do very much in the way of hardening the skin, a shower bath early in the morning, which many patients believe to be a panacea for the evils attendant upon an improper mode of life, often does a great deal of harm to the ears. The worst cases of thickening of the mucous membrane of the cavity of the tympanum not unfrequently result from its use.

(So-called Turkish and Russian baths are very much in vogue in New York as a panacea for catarrh, rheumatism, etc. They are efficient cleansers of the body, and, carefully employed, are good adjuncts in the treatment of aural catarrh, but they are not indispensable, and can never be substituted for local treatment.

The diet should be very carefully regulated in the treatment of catarrh. Hot drinks, or very cold ones, should be avoided, and nourishing, but non-stimulating food recommended. St. J. R.)

LECTURE XXII.

ACUTE OTITIS MEDIA, OR ACUTE PURULENT CATARRH.

Different forms of aural catarrh; symptoms, prognosis and treatment of acute otitis media; it is often overlooked, or not properly regarded; the different forms of deafness in typhus and typhoid fever; manner in which perforation of the membrana tympani occurs.

PARACENTESIS OF THE MEMBRANA TYMPANI.

Historical; method of performance; its employment for the evacuation of pus, mucus and blood from the cavity of the tympanum, in acute myringitis and adhesion of the Eustachian tube; its value as a method of diminishing deafness and noise in the ears; difficulty in maintaining the opening.

GENTLEMEN: The inflammation of the mucous membrane of the middle ear, which we have up to the present time considered, was simple or mucous catarrh. A great increase of the catarrhal process leads, as is well known, to excessive developments of free cell formation, in other words, to suppuration in the inflamed mucous membrane. Observations upon the living and dead subject teach us that *purulent catarrh* also occurs in the middle ear, although much less often than mucous catarrh. There are two forms—the acute and chronic. The inflammatory product, besides containing the puriform element, also contains mucus and epithelial masses, since, as a rule, the inflammatory products of mucous membrane are of a mixed character, and there are a number of intermediate forms between the two different sorts of inflam-

mation. The name *purulent* or *mucous* catarrh only indicates that either one product or the other is in excess, without completely excluding the other.

Whether *croupic* or *diphtheritic* inflammations also appear on the mucous membrane of the middle ear, I do not know. I have not as yet observed any such cases. I examined in two instances the middle ear of children who died from laryngeal croup. In one case the membrane was only hyperæmic, in the other it was greatly swollen on each side, and the cavity of the tympanum was full of pus. I did not find a trace of fibrinous exudation in the auditory canal or cavity of the tympanum. (*Dr. Robert Wreden*[1] reports eighteen cases of *otitis media diphtherica* which appeared in the course of scarlet fever complicated by naso-pharyngeal diptheritis. St. J. R.)

Acute purulent catarrh of the middle ear, or acute otitis interna.—We often find evidences of this disease on the dead body, in children. Of this I shall speak again. We then observe it as a participant and consequence of the exanthemata, measles, scarlet fever, and small-pox, also in typhus fever and phthisis pulmonalis. It also occurs from the exacerbation of a chronic inflammation of long standing, to an acute form, especially when a perforation of the membrana tympani exists. Under very unfavorable circumstances of the patient, or improper treatment, acute simple catarrh may be developed into the purulent form. Acute purulent catarrh also occurs in weakly, scrofulous constitutions, which are disposed to purulent formations, from injuries, or influences which in healthy persons would have only caused a simple catarrh.

Symptoms.—This affection has heretofore been described by most authors as an acute inflammation of the

[1] Monatschrift für Ohrenheilkunde, No. 10.

membrana tympani. The symptoms are very similar to those in acute simple catarrh, which has been previously described, but they are much more severe, and the general condition of the patient is much more disturbed. Cases exceptionally occur, however, where an abscess in the cavity of the tympanum runs its course, and leads to perforation of the drum, without causing any pain or serious disturbance of the system. The pain, which is generally very intense, extends from the ear over the whole side of the head, and increases with every movement; it becomes unbearable if the patient walks on the pavement or other hard substance. The immediately neighboring parts are generally somewhat infiltrated with serum, somewhat swelled and sensitive. There is also a severe burning feeling felt in the depth of the ear in most cases. The febrile condition is so great as to often extend to delirium and stupor.

As a rule, such symptoms as these, occurring in one of the exanthemata, or in typhus fever, and which can only be referred to the ear, are but little observed, in consequence of the danger from the general condition of the patient. In their beginning probably they are never referred to the correct source. The aural surgeon does not, therefore, often see these cases in their incipient stages, if we except those cases in which an old purulent catarrh, with perforation of the membrana tympani, suddenly becomes acute.

The error to which I called your attention in a former lecture—that is, that of confounding an acute mucous catarrh with an inflammation of the brain, may be also fallen into here, for there is always, in acute purulent catarrh, a hyperæmia of the dura mater lying over the petrous portion of the temporal bone, and a proportionate effect on the sensorium. So long as no purulent discharge occurs, the general condition of the patient prevents any particular attention from being paid to the ear, and

the delirious or somnolent patient is in no condition to indicate the seat of his sufferings.

The common result of the morbid process is perforation of the membrana tympani, with which the pain is very much diminished, and a purulent discharge takes place for the first time, if there has not already been a participation of the external auditory canal in the process. There is often developed, at the same time with the purulent inflammation of the cavity of the tympanum, an acute otitis externa, proportionate to the intense hyperæmia in which all the structures are found. According to several sections which have been made in cases where death occurred from typhoid fever, the labyrinth also appears to be in a state of congestion.[1]

In cases where a chronic otorrhœa, with perforation of the membrana tympani, increases to an acute inflammation, the discharge is often suddenly lessened, or disappears entirely. This symptom is often incorrectly interpreted. Such an acute inflammation does not occur because as a result of a certain treatment, or of any accidental coincident injury (cold, a blow on the head), the secretion has been diminished, or, as some are accustomed to express themselves, "driven in," but, on the contrary, the discharge, which has been previously profuse, becomes less from the occurrence of an acute inflammation of the membrane which has previously furnished the secretion, just as we may see the secretion diminished in a chronic catarrh which has suddenly gone on to an acute form.

Simple chronic catarrh after typhus and typhoid fever,

1 The best brochure on diseases of the ear occurring in typhus fever, is from *Dr. Hermann Schwartze*. See "Deutsche Klinik," 1861, Nos. 28 and 30. According to Dr. S., there are three processes in this disease that cause ear affections.

1. Purulent catarrh of the cavity of the tympanum.

2. Catarrh of the pharynx, with closure of the pharyngeal end of the Eustachian tube.

3. Cerebral deafness, due, perhaps, to the poisoning of the blood. According to *Sehert* the deafness in typhus and typhoid fever may result from the general depression of the nervous system.

as in scarlatina and roseola, is quite common, and it is possible for it to run its course without any perforation of the membrana tympani, leaving only a swelled and congested condition of the cavity of the tympanum behind. The more dangerous purulent catarrh may also run its course, and leave no other residue. The fact should also not be overlooked, that the milder and simpler forms of aural catarrh also occur after these diseases.

The most severe and dangerous form of the disease of which we are now speaking, is that in which there is such a power of resistance on the part of the membrana tympani that the abscess cannot be discharged by its perforation. There are a number of such cases on record, where, after the most terrible agony and severest symptoms, the inflammation extended to the membranes of the brain, and death quickly followed. Such cases, especially, can scarcely be correctly interpreted, unless the ear is examined. They, perhaps, occur more frequently than has as yet been demonstrated on the cadaver. The perforation of the membrana tympani, therefore, may be sometimes considered as a favorable turn in the condition of things. Yet, even if an exit be thus formed for the pus, the disease may still go on to a fatal result by a continuation of the suppurative process upon the important adjacent parts. This occurs most often in children, after one of the exanthemata. Later on in these lectures we shall describe such a case in detail.

The objective appearances in the ear, in acute internal otitis, are similar to those of a severe case of simple acute catarrh. The plane of the membrana tympani is altered by the collection of pus behind it, which bulges or pushes out some parts of its surface. Single vessels are not often to be seen, but a general red appearance, indicating the hyperæmia of the mucous surface of the membrane, is mingled with its dull grey color. Sometimes

single red spots (extravasations) may be seen on it. In very acute cases the membrana tympani is sometimes, before the perforation, of an even red color. The swelling of the membrane is usually very great. The osseous part of the auditory canal is generally also affected. In severe cases the mastoid process is painful and sensitive on pressure, and has an infiltrated, shining, red appearance. Examination of the pharyngeal mucous membrane often reveals a considerable swelling and redness, and the Eustachian tube will be found impermeable, except when the catheter is used.

Prognosis.—This is more unfavorable than in the acute form of simple catarrh. Very few physicians can bring themselves to pay the least attention to the ear, in the constitutional diseases of which we have been speaking. Yet they are the very ones in which its functions are most apt to be disturbed. Never are affections of the ear so completely disregarded and placed in the background as in those diseases which confine a patient to bed. How many trouble themselves about the consideration of the ear in typhus fever, in tuberculosis, or in scarlet fever? An American surgeon (Professor Edward H. Clarke, of Boston) says, in an excellent article on "Perforation of the Membrana Tympani, its Causes and Treatment:"[1] "*So necessary is a careful attention to the ear, during the course of an acute exanthema, that every physician who treats such a case, without careful attention to the organ of hearing, must be denominated an unscrupulous practitioner.*" How severe this must sound to the most of German physicians! Certain it is, that if every physician were to inform himself of the condition of the ear and the hearing, as well as of the skin and kidneys, pulse and bowels, many a child would not become deaf and dumb, and many incurable cases of deaf-

[1] American Journal of Medical Sciences, January, 1858.

ness, and many life-long otorrhœas would be avoided. There are such a number of acute diseases in which the ear is also affected, that the physician should always examine as to its condition, without waiting for the patient to announce his affection.

Even with the most careful attention, and when the special symptoms lead us to take every care for the ear, we are sometimes unable to prevent the perforation of the membrana tympani. There will not be very much lost in this event, however, and there is still a wide field left for surgical assistance, in preventing the otorrhœa from becoming chronic, and from leading to evil consequences.

Purulent catarrh of the cavity of the tympanum is certainly the most frequent cause of perforation of the membrana tympani. This perforation may occur from the pressure of the secretion which is constantly collecting. More frequently, however, a rupture of the inflamed, softened, and relaxed membrane, occurs as a consequence of a sudden variation of the quantity of air in the ear. Such a change has the more effect, because the amount of air in the ear is very much lessened, in these cases, by the filling of the cavity of the tympanum, and of the mastoid process, by the swelled mucous membrane. We find, therefore, that the air first passes suddenly through the ear in sneezing or blowing the nose. We then observe in the membrana tympani a linear rupture, and not a round hole, such as results from the bursting of an abscess from pressure. Perforation certainly occurs much more rarely as a consequence of inflammatory disintegration, or ulceration, in myringitis or external otitis, than it does from suppuration of the middle ear. Perforation may also occur from the simultaneous action of various causes.

Treatment.—This must of course be decidedly antiphlogistic. We must practice local depletion according to

the general condition of the patient—by placing a number of leeches around the meatus. We should also fill the ear with warm water very often. Free evacuation of the bowels is scarcely to be dispensed with.

(The use of the aural douche figured on page 95 of this book, is the best method of filling the ear very frequently with warm water. I have lately used it for this purpose, and I have given it into the hands of patients suffering from acute inflammation of the ear, who have derived great comfort from it. The little cup may be placed on a mantel or a table, just a little higher than the patient's head, and then the stream of warm water be conducted into the ear. St. J. R.)

When the otitis, as is often the case in measles and scarlet fever, is accompanied by considerable inflammation of the pharynx, or this has been the origin of the whole process, the greatest attention must be paid to it. You may apply cold water to the neck, or, better, large, frequently-changed, flax-seed poultices; cause the patient to gargle frequently, and, if possible, cleanse the naso-pharyngeal cavity by injections, and, if necessary, cauterize the throat with the nitrate of silver.

It is, of course, extremely important, in this latter class of cases, to secure for the pus collecting in the cavity of the tympanum, its natural outlet, through the Eustachian tube. We therefore employ the air bath, or douche, at an early period, either by means of the catheter, or Politzer's method. This latter should be employed with only a slight amount of force. It is best to employ it by blowing through a gutta-percha tube placed in the nostril.

You must not consider this as too energetic treatment, but remember that perhaps the life and happiness of the patient depend upon your promptness and care. Aural inflammation, in scarlet fever and measles, furnishes the greatest number of the inmates of deaf and dumb

asylums, as well as a large proportion of all cases of deafness of a high grade, in consequence of the readiness of the ear to participate in the exanthemata, and also, as we must confess, from indifference of the physician to this fact.

In cases where the inflammation, and formation of pus are considerably advanced; and where we shall probably not be able to prevent the perforation of the membrana tympani, or perhaps this result is wished for, we may encourage the suppuration by the application of warm poultices to the ear—which are to be omitted as soon as perforation has occurred—or, a paracentesis of the membrana tympani may be performed, which will be better. If a portion of the drum bulges forward, on account of the pus collected behind it, you may make the paracentesis at this point, in other cases on the posterior and lowest part of the membrane, because the cavity of the tympanum is here the deepest.

In one case I was able to see the sudden improvement which occurred after such a paracentesis, without any discharge of pus. A woman working in a factory, who was twenty-seven years of age, applied to me, after having suffered for ten days from a very intense pain in the ear, and a temporary otorrhœa. I examined the membrana tympani, and observed a spot, like a blister from a burn, about as large as a pea, such a one as you may see if the patient has burned the membrane by an ear wash that has been too warm. This could not have happened in this case, since the patient had put nothing at all in the ear. The remaining portion of the membrana tympani had a dense, reddish grey appearance. There was great pain in the ear and the mastoid region, the latter being reddened, the temperature increased, besides being sensitive on pressure. I opened the blister immediately, with an instrument such as is used in paracentesis of the cornea, and evacuated a drop of serum. At this moment the patient breathed

freer, and declared that the pain had almost entirely disappeared, and what was in the highest degree remarkable, the mastoid process was less sensitive to pressure, and the patient was enabled to open the mouth, which she was before unable to do.

In another case of acute catarrh of the cavity of the tympanum, where I performed a paracentesis of the membrana tympani, the influence which the operation had upon the mobility of the lower jaw was remarkable. The patient had been unable for several days to open his mouth, and complained of spasmodic contraction of the muscles of mastication on the affected side. In a few hours after the operation all these difficulties were removed.

Paracentesis of the Membrana Tympani.

This is the proper place in which to submit some general considerations as to the operation of paracentesis of the drum, the indications for its performance, and its value.

Historical.—This operation was first performed on dogs, by *Willis* and *Valsalva*, and subsequently by *Cheselden*. It was first performed on the human subject by a peripatetic miracle worker named *Eli*, about the year 1760, in Paris. *Himly* introduced the operation into Germany in 1797, when he demonstrated the method of its performance on the human cadaver, and living dogs. *Himly* first performed it on a deaf person in 1806. Sir *Astley Cooper* performed the operation in England in 1801. It was very much performed in the first ten years of this century, until the profession became convinced of the rarity of any permanent benefit from it.

Subsequently it was very much practiced in France by *Deleau*, *Menière*, and *Bonnafont*, but it was very seldom undertaken in Germany, until very recently—in 1863, when

Joseph Gruber, of Vienna, again recommended the excision of a portion of the membrana tympani, "myringodectomy," as a remedy for impairment of hearing, and *tinnitus aurium*. *H. Schwartze* has very lately given a very excellent historical and clinical sketch of this subject in the Archiv für Ohrenheilkunde, B. II, 1 and 4, III, 4.

Operation.—For the performance of the operation we may use a needle, such as is used in a paracentesis of the cornea, an explorative trocar, or a slightly curved cataract needle. With this latter we may also cut out a piece from a thickened and resisting membrana tympani. Many of the complicative instruments devised for this operation, seem to be at least superfluous.

It is usually very easy to make an opening in the drum. There is generally a very considerable amount of pain, which lasts for a very short time, however. According to *Schwartze*, when a portion of the membrana tympani bulges forward like a little sac, the operation causes no pain whatever. Very severe reaction follows a paracentesis in rare cases.

The value of this operation, when there is an acute filling up of the cavity of the tympanum with pus, is undeniably the same as that from opening an abscess in any other part of the body. We may thereby save the patient much pain, and have a cleaner and slighter loss of substance than when we leave the opening to nature. This latter fact is of particular value in relation to the membrana tympani, because the artificial opening heals more certainly and readily than a spontaneous evacuation of an abscess of the middle ear, which easily leads to great relaxation or even necrosis of the tissue, so that the healing of the opening is at least retarded.

Besides, the prognosis for the restoration of hearing will of course be more favorable, the shorter the period during

which the middle ear has been filling up, and the sooner we succeed in removing the hyperæmic swelling and puffiness of the mucous membrane. Of course in empyema of the cavity of the tympanum, the air douche or bath, and the evacuation of the secretion through the mouth of the Eustachian tube, are of value, but in severe cases, when the air douche may produce very little or only a temporary benefit, on account of the great swelling of the membrane of the tube, paracentesis of the membrana tympani must be a useful means of treatment. The operation is still more important where the membrana tympani has become thickened on account of previous disease, and hence the probability of a voluntary opening is very much lessened. Such cases not unfrequently end in death. As has been already said, a paracentesis of the membrana tympani, done at the proper time, will prevent the inflammation from extending to the membranes of the brain, and thus may actually save life.

As we have seen, *Schwartze* recommends this operation in simple acute catarrh, when the accumulation of mucus is so great that the membrana tympani is bulged out like a little vesicle. Such a bulging out is generally found in the posterior half, and is most distinctly seen after the air bath. The membrane is yellow from the shining through of the secretion; it fluctuates on contact with a probe, and is not in the least sensitive. In consequence of the extreme tenacity of the secretion, the air douche is not sufficient to drive it out through the tube, and its long continuance in the cavity of the tympanum may easily induce permanent changes in the latter. Then, however, a simple puncture is not sufficient, but an incision of from one to two lines in length should be made. *Schwartze* decidedly disapproves of the operation when there is a slight amount of tenacious mucus in the cavity of the tympanum, because he fears that these small collections are never evacuated

through the opening, and that "very severe reaction often occurs in such cases after the paracentesis; active inflammation, which terminates in suppuration, and often with considerable diminution in the acuteness of hearing."

Paracentesis of the membrana tympani is also very useful, according to *Schwartze*, "in certain cases of acute inflammation of the membrana tympani, where, in a very short time, a very great swelling of the usually dark bluish red tissue occurs, chiefly and greatest in the posterior and upper quadrant, and when, in spite of the use of other remedies, there is very obstinate and severe pain. It quiets the pain and thus shortens the course of the affection."

Paracentesis is scarcely practicable for the evacuation of blood which is in the cavity of the tympanum, because the blood will be coagulated by the entrance of atmospheric air through the Eustachian tube. An artificial opening of the membrana tympani may cause suppuration to occur, while experience teaches that the blood, left to itself, is gradually absorbed.

When there is an impermeable stricture of the mouth of the tube, that is, a true adhesion of the walls of the canal, another indication is furnished for the performance of a paracentesis of the drum. This indication is not very important, for the following reasons: On the one hand, according to the observations as yet made, such an adhesion seems to be an extremely rare occurrence. On the other, it is extremely improbable that it can exist for any length of time, without very great pathological changes taking place in the middle ear, from the retention of the secretion, and the permanent increase in the hydrostatic pressure in the cavity of the tympanum and the labyrinth, which would prevent any result from the operation.

In those cases where, from repeated examination with the catheter and bougie, we must believe that the existence

of an adhesion of the walls of the canal is very probable, we would certainly be justified in an explorative puncture of the membrana tympani.

The cases as yet seen are collected by *Lindenbaum* in the "Archiv für Ohrenheilkunde," 1, s. 295.

(According to *Lindenbaum* there are four authentic cases of closure of the pharyngeal orifice of the tube, usually by cicatrization from syphilitic ulcers. The cases recorded in the older text books give no evidence that an actual closure of the tube existed, but what we would now call impermeability of the tube to air at the times when the Eustachian tube normally opens, *i. e.*, during swallowing, violent respiration, etc. St. J. R.)

Schwartze made a paracentesis in one case, in which, although the rhinoscope could not be used to verify the diagnosis, he supposes the walls of the tube to have been adherent. In three days the opening had closed, and the improvement to the hearing which immediately followed the operation, was gone.

Paracentesis of the membrana tympani may also be of value in cases where the impairment of hearing depends, at least in part, on thickening and inelasticity of the membrana tympani, which have thus become an impediment to the conduction of sound.

Whether this be really the principal cause of the impediment, or whether it depends on a thickening of the membranes of the fenestræ, we cannot determine in advance. As *Wilde* has already said, very frequently the thickening which we do see on the membrana tympani, is only a part of the common thickening and disorganization of the whole membrane of the middle ear, which we do not see, and under such circumstances a hole in the membrana tympani can cause no benefit to the hearing. If, however, the thickening of the membrana tympani depends on an hypertrophy of the cutis, and of the epidemis, as is quite frequently the case after chronic inflammation of the membrana tympani and the auditory canal, appro-

priate instillations, and pencillings of the parts, will generally lessen the thickening very much, as has been already mentioned. I have before shown you that a very considerable amount of calcareous degeneration may exist on the membrana tympani in connection with a good hearing power; hence the existence of these calcareous degenerations are never of themselves a sufficient indication for the performance of a paracentesis of the drum of the ear.

Joseph Gruber[1] adds to the indications for this operation, "anomalous adhesions of the structures of the middle ear (if these anomalies be positively recognized), in order to prepare the way for the breaking up of these adhesions." With *Schwartze*, he considers it possible that this indication may be of value in the future. There are, however, as yet, no sufficient proofs of the value or permanence of the result.

Wilde first proposed paracentesis of the membrana tympani, as already stated, for very troublesome tinnitus aurium. He suggested it in consideration of the fact that it was only rarely that we met with persistent and very troublesome tinnitus in a case where the membrane was perforated. *Schwartze*, following this indication, has perforated the drum very many times without any decided or permanent result. In one case, only, was the noise considerably lessened after the cicatrization of the portion that had been incised. In two cases where I perforated the membrane on account of very great noise in the ear, the relief was very great, but it disappeared completely as soon as the opening had closed.

The short duration of the improvement to the hearing is the worst feature in this operation. It is usually very easy to perform, but its value in improving the hearing

[1] Allgemeine Wiener Mediz. Zeitung, 1863, Nos. 39-43; 1864, Nos. 13-16; also in Archiv für Ohrenheilkunde, II, s. 58.

and lessening the noise in the ear, whatever it may be, is soon lost. It seems, as yet, impossible to devise any way by which an artificial opening in the membrana tympani, or even a loss of substance, can be kept from closing up again.

It is frequently as difficult to keep an artificial opening from closing, as it is to close one that has been produced by disease, and which has existed for a long time. We may cauterize the edges of the aperture, cause the patient to practice the Valsalvian method of inflating the ear; we may place bougies, little tubes and the like, in the opening, and yet the great regenerative power of the membrane of the middle ear will generally laugh at all these attempts to maintain a perforation.

Bonnafont[1] has performed paracentesis twenty-five times within three years on one patient, without ever succeeding in keeping an opening longer than some months.

Among the many reports of favorable result from this operation, none of them can be said to give any sufficient evidence of its real value (of course I am now speaking of the paracentesis performed in cases of chronic catarrh, and not of those where it has been done as the opening of an abscess), unless the patients have remained for a long time under observation after the operation. Most of the histories are, in this respect, imperfect, and I must therefore fully coincide with *Schwartze* when he says that, up to the present time, "it is only in very rare cases that a permanent success has been seen by trustworthy observers."

If a case occurred to me where it was extremely necessary to maintain an opening in the membrana tympani, I would make a large flap in the membrane, and attempt to cause it to adhere by pressure or attachment to a portion of the cavity of the tympanum, or auditory canal, whose

[1] Traité théor. et prat, des maladies d' l'oreille, Paris, 1860, p. 375.

ıce has been previously freshened. It is in a manner lar to this, that we find that natural perforations of nembrana tympani are formed, which resist all attempts eal them up.

ɔltolini,[1] of Breslau, has recently perforated the membrana tym- by means of the galvano caustic apparatus. The operation can ne without chloroform, it causes no pain, and it is hoped that pening made will be permanent. In the case in which *Voltolini* rmed the operation, the deafness was absolute. It occurred continued fever, during convalescence, and there were very lesome head symptoms, heaviness, tinnitus, etc. The latter greatly relieved, the deafness, however, was not at all improved, a very slight degree.

. *Wreden*,[2] of St. Petersburg, excises the handle of the mal- in cases of sclerosis of the middle ear, with deafness and tin- He has devised an instrument for the operation. St. J. R.)

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LECTURE XXIII.

PURULENT AURAL CATARRH IN CHILDREN.

Up to this time chiefly known through pathological study; an attempt at an explanation, and its practical value; Dr. Wreden's cases.

GENTLEMEN: I am about to speak to you of a form of purulent catarrh which I am acquainted with only from post mortem evidences, and which, as seen in the living, I must leave to those who have sufficient opportunities to study the diseases of children. In the course of my examinations of the normal and pathological anatomy of the ear, I came accidentally on a peculiar condition in the ears of very young children, which excited my attention the more, because I observed it so frequently, that is, in the greater number of infant subjects of which I have had the opportunity of making a post mortem section. I examined forty-eight petrous bones belonging to twenty-five children, and when I except one case of caries of the temporal bone, on each side, I found, in the remaining forty-six bones belonging to twenty-four children, the middle ear normal thirteen times in seven children, while the remaining thirty-three ears of seventeen children were affected with purulent catarrh of the middle ear. The cavity of the tympanum, the upper portion of the Eustachian tube, and the cells of the mastoid process, were filled with a greenish yellow substance, which was sometimes creamy, again a gelatinous fluid, that looked like pus, which it proved

to be, under the microscope. It appeared composed of roundish cells, with a quadrilateral nucleus or nuclei, which were often visible without the use of acetic acid. The clouded contents of the cells cleared up on the use of the acid, but they very frequently contained little fat granules. These collections of pus filled the whole of the space which the swollen mucous membrane had left. The mucous membrane was always in a very hyperæmic condition, and occasionally there was a net-work of very delicate vessels. The membrane was, as a rule, so hypertrophied that the *ossicula auditus* were imbedded in it, and their outlines were scarcely to be made out. The mucous membrane of the membrana tympani also appeared slightly infiltrated, and covered over with a net-work of vessels. The membrane was never perforated or in a state of ulceration.[1]

Schwartze found in several cases, together with similar appearances, hyperæmia in the membranous labyrinth, and once even pus in the cochlea, so that the structure of the membrane of the *lamina spiralis* was completely destroyed by the surrounding pus.

With these appearances there also appeared, in eight cases, and always in those where the contents were of a gelatinous consistency, peculiar red bodies, from the size of the head of a pin to that of a hemp seed, which were quite hard to the touch, and were firmly attached to the mucous membrane. On nearer examination they proved to have a very vascular cortex, and an internal structure, sometimes consisting of granular-like fat, again of cells. All other explanations are wanting as to the nature and origin of these puzzling bodies, to which I know no analogous structures.

The bodies of which the examination were made were taken without choice, as they were furnished, during the space of three years and a half, partly from the city and

[1] Archiv für Ohrenheilkunde, I, s. 203.

partly from the lying-in institution, to the pathological department of the Medical School in Würzburg. The youngest child was seventeen hours old—the oldest, one year. Of the children with a normal middle ear, two were fourteen days old, one seventeen hours, one four days, and the remaining three, six and eleven months, respectively. The bodies were often such as were furnished to the students for the study of normal anatomy, since in the post mortems which had been held, the immediately affected portions were the only parts examined. Twelve were of this class. The other post mortem appearances were various, corresponding to the condition in life of these poorly-cared-for and half-starved children. The diseases of which they died were atrophy, inflammation of the bowels, partial collapse of the lung, and bronchitis. There was venous hyperæmia of the coverings of the brain, and congestion of the brain substance, in almost all of the observed cases. In those cases in which there was no pus in the cavity of the tympanum, there were no other pathological appearances. Thus much for the facts.

Although the number of petrous bones thus examined is not very large, it is sufficiently so—since the subjects were taken without choice, and during quite a large space of time—to allow us to say that the middle ear of young children, when examined *post mortem*, is very often found in a condition of purulent catarrh.

Now, gentlemen, what shall we conclude from the development of these very unexpected facts? Can we believe that we are here dealing with a normal and physiological, and not a pathological condition? Masses of pus, when found in a normal atmosphere, an hyperæmic, greatly swelled mucous membrane, instead of a smooth, thin, and moderately vascular one, form a condition that can only be considered as pathological, and all the more so, since all the petrous bones examined were not found in

this condition, but one-fourth, or thirteen out of forty-six examined, contained no pus or hyperæmic membrane.

The experience of physicians, however, has not shown that purulent inflammations of the ear appear as often in young children as would be thus indicated. May it be true that such an otitis interna as our examinations have shown, is only an anatomical or normal condition, and that it never evinces itself by any disturbing symptoms during life?

As I have already said, I am not able to give a positive answer to this question. Is it probable, however, that changes in structure similar to those which in adults give rise to evident symptoms, and which affect not only the part involved, but the whole organism, is it probable, I ask, that these changes produce no results, when occurring in children? In general we know that the nervous system and general condition of a child reacts even as strongly as that of an adult to any disturbing cause. As long as we have no positive evidence of such a change in the relative irritability of children and adults, may we not assume that a whole class of symptoms occurring in sick infants have been improperly estimated, or imperfectly observed, that is, that they have been overlooked? I have been obliged, in almost every section of aural surgery which we have studied together, to show you more or less important facts, which have either not been considered sufficiently, that have been improperly estimated, or those which have escaped the observation of practitioners, and, for the greater part, of aural surgeons also. I will at this time only recall one instance to your mind. How far, hitherto, have physicians known that impairment of the intellectual powers, a heaviness of the head, and troublesome attacks of vertigo, have had anything to do with a diseased condition of the ear, while the daily occurrence of such cases to the aural surgeon proves the coexistence of these symptoms with aural disease? Notwith-

standing this, the most cultivated clinical physicians seem to have no idea of the signification of these symptoms, and you will not find in the writings of the older German aural surgeons anything to indicate that they may be observed.

Nowhere dare we leave less to authority, nowhere can we rely so little on previous researches, and nowhere can considerate and assiduous observations of clinical and anatomical facts find so much that is new and unexpected, as in the pathology of aural surgery. The previous laborers have left much to be done. How insufficient and wanting have been the observations hitherto made on the living, I have already shown you. I have been obliged, also, to show you that observations on the dead body in some directions are entirely wanting, while in others they are incomplete.

If, for instance, in the examination of the infant cadaver, attention had been turned to the temporal bone, the striking appearances then seen would have certainly arrested the attention of the physician.

Schwartze has recently called attention to the fact that *Du Verney*, a Frenchman, had shown the condition of things that I have described as occurring on the infant cadaver, nearly two centuries ago. In his *Tractatus de Organo Auditus*, his words are: "*Aperui etiam complurium infantium aures, in quibus tympanum excrementis erat plenum, interim nunquam, neque in cerebro neque in osse petroso, inventâ ullâ pravâ dispositione.*"

Henle's Hand-book of Anatomy (11 Bd., 1866, s. 737) also called attention to a dissertation given at Marburg, in 1857, by *Koppen*, "on a collection of fluid in the tympanic cavity of the newly born." Koppen found the cavity of the tympanum empty in three children only, while a fluid which could not, however, be described as pus, existed in eleven cases.

The examination has been neglected; the facts have, consequently, not been shown, and even now it is only exceptionally that a physician who can give no point of

origin for the pain, thinks of the ear, and of the possibility of an inflammation there, until a purulent discharge shows itself.

If we examine the literature of the subject more closely, we find that in various times, observing and careful men have plainly shown that perforation of the membrana tympani, and the otorrhœa following it, were merely the results of otitis interna, that this must always be more common than otorrhœa, and that should we attempt to recognize the affection at an earlier date, in order to guard against the purulent discharge, and cause the whole process to run a mild course. In 1825, Dr. Schwartz, a physician in Fulda, said, that "inflammations of the ear occurring in children not old enough to speak, are very often overlooked," and he called attention to the symptoms by which they might be distinguished from other affections, especially from inflammation of the brain and its membranes.[1] Frederich Lud. Meissner, in his Text-Book of the Diseases of Children, says, that "aural inflammation is of that kind most commonly overlooked in childhood, because infants are not able to indicate the situation, kind, and degree of the pain."

It is most commonly confounded with diseases of the brain. According to Helfft (1847), "the symptoms of otitis interna in children are very similar to true meningitis.[2] We must always look to the head as the point of origin of loud and intermittent cries of pain, when the chest and abdomen have been found in a normal condition. The absence of vomiting and constipation, as well as the slight febrile reaction, are proofs that there is no considerable inflammation in the brain."

[1] See *Siebold's Journal für Geburtshilfe*, B. 5, Hft. 1. Again presented in the third part of *Linke's Sammlung auserlesener Abhandlungen und Beobachtungen aus dem Gebiete der Ohrenheilkunde.*

[2] *Journal für Kinderkrankheiten, Schmidt's Year-Book.* 1848. B. 58, p. 337.

These various indications seem to have been little regarded; and since they were given we seem to have gone backward, for you will find no attention paid to the subject in our present text books. In the well-known works of *Rilliet* and *Barthez* (1853), and in that of *Bouchut* (1852), I can find nothing pertaining to the subject, and quite as little in other text-books on the diseases of children, even in those which have appeared since 1858, in which year I made my first communication concerning this peculiar post mortem appearance in infants, to the medical society of this city.

Hauner,[1] however, has recently said of otitis: "In very young children it is often difficult to recognize this affection, because the symptoms are very similar to those from those of a cerebral disease—acute meningitis. It is only by a consideration of all the symptoms, and of the physiognomy of the child, that we may be able to determine the seat of the affection."

As far as my knowledge extends, the only physician for children, who has as yet given this subject any special attention, is Professor *Streckeisen*, of Basle. We may expect that we shall yet receive still more detailed communications as to his observations in this direction. In his report of the Child's Hospital in Basle, on page 13, he says: "Five children died of meningitis and encephalitis. In four cases severe purulent catarrh of the cavity of the tympanum was found, which must be regarded as the point of origin of the disease. In one case the inflammation of the brain existed in a pure form." Again: "In pneumonia occurring in infants who were brought up by the bottle, convulsive symptoms generally occurred in the last three days. The explanation of these was found, on a post mortem examination, to be a catarrh of the cavity of the tympanum, and incipient meningitis."

[1] Beiträge zur Pädratrik, Berlin, 1863. B. I, s. 227.

I am somewhat in doubt whether the form of disease described by *Rilliet* and *Barthez* as "cerebral pneumonia," and by *Ziemssen* as "croupous pneumonia with cerebral symptoms," was not in the most cases an inflammation of the lungs, with purulent catarrh of the cavity of the tympanum. I confess I consider this very probable. We should never neglect to examine the cavity of the tympanum when such cases occur. It is not very difficult to do this.

But, gentlemen, not only anatomical facts, but also daily practical experience, prove to us the uncommon frequency of diseases of the ear in children. Ear-aches are such common occurrences in children who are old enough to exhibit the seat of pain, that we scarcely know a child that has not suffered, at one time or another, with them. Examination shows that this ear-ache generally depends upon inflammation of the external or middle ear, and that it is seldom of a nervous or neuralgic nature. Of the otorrhœa that comes under our care, the greater part, certainly more than half, has its origin in childhood or infancy. Impairment of hearing, of different grades, will often be found in children when a test examination is made.

If, then, it is a generally acknowledged experience that inflammatory diseases of the ear are quite common in older children, it is probable that they occur quite as often in the very first periods of childhood, and that we are not able to detect it, simply on account of the difficulty of recognizing an aural affection in infants, when there is no purulent discharge.

The anatomy of the parts, and the history of their development, also prove how favorable circumstances are, in infancy, to disturbances of nutrition in the cavity of the tympanum.

I may recall to your recollection that process of dura mater, so rich in vessels, which in childhood extends along the whole of the *fissura petroso-squamosa*, to the cavity of

the tympanum and the mastoid cells, and through which the dura mater and the mucous membrane of the middle ear come into closer relations in respect to nutrition than is the case with adults. Each of the disturbances of nutrition and circulation in the membranes of the brain, such as are quite common to children, must extend to the middle ear, from the fact that the blood supply of both is conveyed in the same channel; and the reverse is also true—every primary affection of the ear in a child is apt to produce symptoms of cerebral disturbance. I must not omit to state that, in all the cases of infantile external otitis, where I was allowed to make a complete examination, I found also congestion and hyperæmia of the brain.

I have still further to speak to you of the condition in which we find the cavity of the tympanum in the fœtus and the newly born child. As I have shown,[1] it is filled up with a cushion-like swelling of the mucous membrane of the wall of the labyrinth, which reaches up to the smooth internal surface of the membrana tympani. The respiratory process soon diminishes this mucous proliferation, partly by shrinkage and increased desquamation, and partly by degeneration of the structure, and causes it to give place to air.

We know from daily experience, that in the first period of life a developing process, or better said, a recession process is going on in the middle ear. Our daily practical experience teaches us that pathological changes, inflammations, and new formations interfering with the nutritive processes, are more easily produced in parts which are increasing in power, and where metamorphosis and evolutions are going on. As an example of the truth of this, you will remember how often diseases of the female sexual system originate during the time of development,

[1] Würzburg Verhandlungen. B. 9, case 78.

during each menstrual period, and especially during the puerperal process.

If we add to these facts, that nasal and pharyngeal catarrh, which so often give origin to catarrh of the ear, are an every-day experience with children, you will be less surprised at the uncommon frequency of otitis in the young subject, and the only question will be whether we are able, with some certainty or probability, to recognize the affection during life.

If the function of respiration be indeed of as great importance for the middle ear as *Lucae's* experiments show, all pathological processes in the organs of respiration, and particularly deficient respiration, such as is quite often seen in atelectasis of the lungs, must very readily lead, especially in children, to abnormal conditions in the cavity of the tympanum. It is even conceivable that a long-continued death struggle (Agonie), under certain circumstances, may lead to the above described condition in the ears of small children.

You comprehend, gentlemen, the difficulty of a diagnosis of an affection of the ear, unaccompanied by a discharge, in young children who are not able to designate a situation for their pain, and when it is almost impossible to make any sufficient examination of the part, or to determine the degree of hearing. You see that we want nearly all the fixed points, such as in adults, enable us to distinguish an inflammatory affection of the ear. Yet, you must not allow this state of things to deter you from your duty. In internal diseases, especially in the practice among children, we are very often obliged to be content with very few positive conclusions, to diagnosticate by exclusion, or from greater or lesser probabilities, and also to look very much at the result of our therapeutics. We are not, strictly speaking, in a worse position for the formation of a diagnosis in these aural cases than in many others. The principal difficulty lies in the fact that:—

the physician who approaches the bed of the sick child scarcely counts non-suppurative inflammation of the ear as among the various possibilities which go to clear up the symptoms. If we but once understand that diseases of the ear belong to the more frequent ones of children, and compare the symptoms with which these affections declare themselves in grown persons, with those peculiar to the infant organism, we may certainly be able, by exclusion of the other organs, to make our circle narrower and narrower, until finally, with more and more certainty, we fix upon the ear as the origin of the trouble. Our conclusions will also be assisted by a previous experience.

Allow me, then, to enter into a further detail of the symptoms by which otitis interna will show itself in young children. I must declare, however, that a diagnosis from analogy is only allowable because in the peculiar circumstances clinical proofs of a definite pathological condition are wanting. Parents, who bring their children with otorrhœa to the physician, will often give considerable information as to the condition of the patient the day before the discharge began.

When the collection of pus is at all considerable, the symptoms of irritation can scarcely be wanting, and the affection will declare itself by a morbid disquiet, and by the loud cry of severe pain. Some physicians ascribe a peculiar character to the cry of children in otitis; whether this be true or not, we may leave undecided. Certainly the cry which arises from pain in the ear, even when coming from strong men, may be described as one of the most agonizing, it being extremely severe and penetrating. This pain sometimes lasts for hours, often even for days, without very long intermissions, until hoarseness and complete exhaustion have ensued, and severe exacerbations often occur, especially during the night.

The shrieking will distinguish it from affections of the

lungs, pleura and trachea, since in these diseases children can never cry loudly or for any continued length of time. The cry from ear-ache most resembles that from inflammation of the bowels or brain, but the absence of the remaining symptoms of these diseases will enable us to distinguish trouble in the ear from these diseases.

It will be important to note the circumstances under which the pain seems to be decreased or increased. In affections of the middle ear the pain is increased by every movement and shaking of the body, and every change in the position of the head, by every effort of swallowing, and in suckling the child will fling itself away from the breast, or from the bottle, at the first attempt, while its usual nourishment, administered by means of a spoon, will be more easily taken. If the affection be in one ear only, the child will cry more violently if placed upon the affected side. Cold and noise will increase the pain, while perfect quiet, warmth, especially moist warmth, such as pouring warm water into the canal, and the application of cataplasms over the ear, will quiet the pain. Nasal catarrh — cold in the head — will be a common complication.

You will find it very difficult to come to any conclusion as to the degree of deafness, or loss of hearing, which is connected with the accumulation of purulent matter in the middle ear. It is true, that even in the most tender age we can come to an unequivocal determination as to whether the child hears a loud noise or not, but who can tell, in a disease connected with depression of the sensorium, whether a child does not respond to sounds, from want of power in his auditory apparatus to conduct the sound, or from want of power of the brain to perceive it? When we remember the facts, often alluded to, of the relation of the vessels of the dura mater and the mucous membrane of the middle ear, in the child, and the tendency of

extension of diseases of the ear to the brain in the adult, we need not be surprised—considering the very impressible brain and spinal cord of the child—if the meningeal and cerebral symptoms are here much severer than in adults, and that stupefaction, or convulsions of the limbs, or spasms of the facial muscles, are produced by an otitis media. Nasal catarrh is one of the common symptoms. I must very earnestly urge upon you the employment of Politzer's method of inflating the drum in such cases. We should often force the air into the ear, and observe what effect it has upon the pain, disquiet, and crying of the little patient, and notice especially if it makes any impression upon the blunted or irritated condition of the sensorium.

The fact may have occurred to you that, in the post mortem examinations, whose results are now under consideration, the membrana tympani was never found perforated, and that it took very little part, comparatively, in the morbid process. This may be due to the width of the Eustachian tube in infancy. It is not only relatively, but absolutely wider than in adults, measuring, in its narrowest part, about a line and a half, or three mm. Therefore, a complete closure of the cavity of the tympanum, and a consequent collection of secretion in it, with the well-known results, is not so liable to occur. These anatomical conditions allow us to say, that in otitis there is much less danger to the membrana tympani of children than in that of adults, and that the prognosis is, on the whole, better in the former than in the latter. Perhaps the disease may run its course in the young subject without any decided pain.

Treatment.—What shall be the therapeutics for an otitis interna thus in all probability diagnosticated, as

occurring in an infant? In the case of a strong, well-developed child, we may apply one or two leeches behind the ear to relieve the pain and hyperæmia. I would not generally apply poultices to the ear, since they will certainly excite a profuse otorrhœa, and the frequent filling the ear with warm water will probably subdue the pain quite as effectually.

Injections of cold or lukewarm water in the nose will have a good effect in removing mucus from the nasal cavities and upper pharyngeal space, and they are especially to be recommended when there is a severe cold in the head, which is a frequent accompaniment of the otitis. They also serve to assist in the diagnosis.

I would like to speak of a popular remedy for cold in the head, that often does good service in many forms of nasal catarrh occurring in children—that is, the insertion of an oiled and pointed pigeon's feather through the nose into the pharynx; this is to be done at somewhat frequent intervals. It excites sneezing, and assists materially in clearing out the parts. Since there is a very slight amount of danger to the membrana tympani, and the secretions of the cavity of the tympanum are easily removed, an emetic will be very useful in some cases.

Politzer's method will be found particularly important, not only in the diagnosis, but also in the treatment of this purulent catarrh. By this method the tube is opened and the possibility of an exit is afforded to the pus that has collected in the upper part of the canal. We have already seen how easily the manipulations necessary in this procedure are made in the case of children, where the simultaneous swallowing is not essential to the success of the attempted inflation.

I hope, gentlemen, that you will follow out this subject in your future practice, and when you can ascribe no sufficient reason for the crying of a child, and for its stupid

or convulsive condition, that you will remember the frequent recurrence of the pathological picture which we have seen in these sections, especially if the existence of a severe cold in the head indicates a catarrhal affection in the ear.

There is a prevailing custom among many physicians, to ascribe many of the troubles of the first period of life to the cutting of the teeth. We can not deny that this view has historic right, as well as the *vox populi*, on its side, and that it is extremely convenient. It does not appear to me, as proven, however, that a physiological process for which preparations have been made, and which goes on with so few local and sudden changes, should constantly lead to constitutional disturbances of the system.

According to *Kölliker*, the development of the twenty milk teeth begins as early as the sixth week of fœtal life, and in the seventh fœtal month their ossification has begun. In the remaining teeth the first stages of development begin at the fifth month of intra uterine life, and ossification begins before birth.

Let it be as it may, I do not intend to express myself very decidedly on the vexed question. This much is certain, that abominable malpractice is often seen in difficult dentition; exact examination is often omitted, for the above-mentioned convenient subterfuge, while many very important local disturbances are overlooked. Among the last, may we not place the variety of otitis, which has just been described.

I am in possession of but one complete history of a case of an older child, where the above described pathological conditions were found, for which I am indebted to the kindness of my honored friend, Professor *Streckeisen*, in Basle. (I take the liberty of somewhat con-

densing the case, which Dr. Tröltsch gives in full on page 308 of the original of this work. St. J. R.)

A well-developed, healthy child, six years of age, after returning from a walk, was seized with headache, heaviness, and bilious vomiting. After a restless night, on the following day the symptoms disappeared. On the evening of the second day, the same symptoms return, surface heated, pulse 130 — all the appearances of congestion of the brain. Treatment, leeches between lower jaw and mastoid process, cold application to the head, cathartic. Symptoms disappear and do not return for three or four days.

Fifth day. All the symptoms of cerebral congestion reappear — restlessness, disposition to weeping, anxious visage, head hot, slow drawing back of the tongue, etc. Blood was taken from the Schneiderian membrane, cold applications to head, and cathartic of calomel. Symptoms again disappear.

Sixth day. Gradual symptoms of cerebral pressure began to appear, drowsiness, some difficulty in waking, remaining till seventh day, when pouring cold water over the head seemed to have somewhat revived the patient, though not fully.

Eighth day. Paralytic symptoms appeared.

Ninth day. Increased.

Tenth day. In the morning she died.

Sectio cadaveris showed serious infiltration and congestion of the brain, swelling of brain substance, and consequent pressure. Both lateral sinuses filled with coagula. Cavity of the tympanum, and mastoid cells, on both sides, filled with pus. Mucous membrane of the ear greatly injected and swollen. Membrana tympani slightly sunk inward.

The following facts are especially remarkable in this case:

I. The very slight prominence of the pain in the head on the first and second days. On the reappearance of the affection on the fifth day, this symptom appeared, accompanied by sobbing and crying.

II. Entire want of convulsive symptoms during the period of irritation, rapid progress of the cerebral pressure, and paralysis.

III. Entire absence of pain referred to the ear. Although this point was not specially observed, still this much is certain, that the child did not complain of pain, and that it heard well on the sixth or seventh day of the duration of the disease, for during the intervals of consciousness it gave correct answers to its brothers and sisters.

It is much to be desired that physicians who see much of infantile diseases, would interest themselves in this matter of the occurrence of otitis, and thus bring us to some exact conclusions. I would myself be very thankful for any communications on the subject.

(The translator would be very thankful for any opportunities to examine, post mortem, the auditory apparatus of young children.

While these pages were passing through the press, Dr. *Robert Wreden*,[1] of St. Petersburg, published an article which throws very considerable light upon this subject of aural inflammation in the newly born. I regret that the article is as yet incomplete, and that consequently the full conclusions can not be given. They are here presented as far as they have been published.

Dr. *Wreden* has examined the auditory apparatus of eighty infants. They were all foundlings. The youngest was twelve hours old, the oldest, one year and two months. The greater number were only from three to fourteen days old. There were no very marked pathological changes in fourteen ears, or seventeen and one-half per cent. All the infants whose ears exhibited disease to any considerable extent, died of severe affections; thirty-six of *pneumonia*, sixteen of *atelectasis congestiva*, eleven of *hyperæmia meningum*, eight of *ædema meningum*, three of *meningitis suppurativa*, and so on. It is thus seen that they died of affections which must necessarily involve the auditory apparatus, in view of the intimate anatomical relation existing between both the cerebral cavity and respiratory organs to the mucous membrane of the middle ear. In only one case was the ear primarily affected. It then led to a fatal constitutional disease. Of the fourteen ears in which the pathological changes in the ears were slight, five were in a perfectly normal condition. In the nine remaining there was a slight venous hyperæmia of the mucous membrane of the middle ear, which was probably a post mortem change.

The following conclusions were reached by Dr. *Wreden* from an examination and study of the cases above cited:

1. None of the children who had normal ears died of pneumonia

[1] Monatsschrift für Ohrenheilkunde, July, 1868.

or meningitis. This was shown, of course, by a post mortem examination of the brain and lungs.

2. Those cases in which there was a slight amount of hyperæmia, were those in which there was but very little congestion of the lungs or brain.

3. The mucous cushion, discovered by Tröltsch (vide page 406 of this work), which fills the cavity of the tympanum of the fœtus, is completely absorbed in the first twenty-four hours after birth. This is proved by two cases of children a day old, where the cavity of the tympanum was perfectly free, having a smooth and normal mucous membrane. The body of an infant twelve hours old, showed that this cushion of mucous tissue *was not absorbed in that time.* The process of absorption was, however, going on, so that the tissue existed only on the roof of the cavity, in the mastoid cells, and on the labyrinth wall. The respiration, crying, and suckling of the infant, are the actions which promote the absorption of this tissue. The cavity of the tympanum in children who were born dead, was completely filled by this mucous cushion. This is an important fact for medical jurisprudence. Tröltsch's idea that this tissue underwent a peculiar degeneration, and thus occasioned suppurative formation in the cavity of the tympanum, can not be sustained, but, knowing that complete absorption of this mass, should occur in twenty-four hours after birth, we may consider Tröltsch perfectly justified in asserting that every formation of pus in the ear of the newly born, must be regarded as a pathological condition.

4. Of the eighty children, thirteen, or sixteen and one-fourth per cent were affected with *otitis media acuta*, or acute catarrh of the middle ear.

5. Simple or mucous catarrh of the middle ear was found seventeen times in the eighty children. This affection was never accompanied by consecutive inflammation of the brain and its membranes.

6. Purulent inflammation is among the most important and frequent diseases of the infantile auditory apparatus. It occurred thirty-six times in the cases under consideration. More than half the cases of suppurative inflammation of the middle ear were accompanied by consecutive affections, which were often the direct cause of death.

7. The membrana tympani was found to be perforated in but one case. This is a peculiar fact, that should be well-considered in the diagnosis and prognosis of *otitis media purulenta neonatorum.*

Dr. *Wreden's* interesting article concludes with a reference to the importance of the function of respiration for the integrity of the ear, and refers to the investigations of Lucae, Schwärtze, Politzer, and Tröltsch, on the movements of the drum synchronously with the respiration, which have been already quoted from in this work. *Lucae* says: "It is not improbable that all affections which impair the respiratory act, also more or less directly impair the respiratory movement of the membrana tympani, and thus may lead to certain aural affections." The observations of *Rudinger* and *Mayer* show that there is a constant communication through the Eustachian tube with the outer air, and are also evidence that affections of the respiratory organs may easily extend to the ear.

In adults, also, the ear may be consecutively affected, when diseases of the lungs exist. In the last stages of *phthisis pulmonalis*, impairment of hearing and *tinnitus aurium*, consequent upon consecutive aural catarrh, often occur. In cases of pneumonia, œdema, laryngeal croup, etc., no examinations of the middle ear have as yet been reported. St. J. R.)

LECTURE XXIV.

CHRONIC PURULENT AURAL CATARRH, OR CHRONIC OTITIS MEDIA.

Objective and subjective symptoms; treatment; perforation of the membrana tympani; its importance, and the frequency with which it heals.

THE ARTIFICIAL MEMBRANA TYMPANI.

Historical; the various kinds; principle on which it acts.

GENTLEMEN: We may now turn to the consideration of the chronic variety of purulent aural catarrh. This form is much more common than the acute. It is either developed from the latter, or it arises from the extension of an otitis externa, or an inflammation of the membrana tympani to the cavity of the tympanum. Not very unfrequently, however, suppurative catarrh of the ear appears primarily in a chronic form, that is, without any preceding acute inflammation, and has a very slow course from its very beginning.

We can hardly conceive of a long-continued suppurative inflammation of the middle ear, without the occurrence of perforation or destruction of the membrana tympani. In case it is not impaired, the membrane must have been greatly thickened by some previous affection. The pus from the deeper parts of the ear will naturally run outward. We may call this form of discharge otorrhœa interna, in contradistinction to otorrhœa externa, in which

affection the membrana tympani may remain intact for a long time.

In the greater number of cases, the beginning of chronic otitis interna may be traced back to early childhood. The symptoms are mostly limited to impairment of hearing, and a purulent discharge from the ear, both of various grades and intensity. Pain is only felt after some distinct causes have been at work—such as an injury to the part during an ulcerative process, or during the sub-acute stages, or when an ulcerative or carious action is taking place. In the last named case the pain is very severe and long continued.

If we syringe the ear we observe two kinds of secretion. The purulent, which is equally mingled with the water injected, and colors it yellow; and a mucous secretion which is not dissolved in the water, and which floats around the vessel in long and irregular grey flocculi. Sometimes there is more pus than mucus, and again more mucus than pus. There will also be little lumps, which consist of the dried secretion or epidermis from the canal and membrana tympani.

On examination the lower part of the auditory canal is superficially softened and relaxed. The osseous part of the canal is often narrowed, and above and laterally it is covered by discolored crusts, consisting of dried and thickened secretion, or the lamellæ of epidermis. These are often so large as to prevent a view of the background, and their removal alone may considerably improve the hearing. When the parts are greatly swollen, or the perforation is very small, it is often difficult to tell, even when the ear has been cleansed by a syringe, or a camel's hair pencil, whether there is any abnormal communication between the outer and middle ear or not.

The presence of mucous flocculi in the water that has been syringed into the ear, indicates that the secretion is

from the middle ear. Air bubbles also lead us to suspect a perforation; a pulsating movement of a drop of fluid in the depth of the ear, is not seen, at least as a rule, unless the membrana tympani be perforated.

Pulsating movements also occur, but very rarely, on a membrana tympani that is not perforated.[1] Politzer has also observed them on the swelled mucous membrane of the promontory.

(I have the record of a case of acute aural catarrh, where the pulsation was distinctly seen in the upper and posterior segment of the drum, by myself, and my friend, *Dr. Rider*, who happened to be in my consulting room when the case was presented. The drum remained intact throughout the course of the disease. St. J. R.)

The perforation is seen most distinctly if the patient blows his nose or presses air through the tube. If the latter be permeable, the perforation small, and the secretion not too slight in amount, a whistling sound will occur, and at the same time secretion is not unfrequently forced into the auditory canal.

On the other hand, there may seem to be a perforation when there is really none. A portion of the membrana tympani that is red and sunken may be easily mistaken for mucous membrane of the cavity of the tympanum. The edges of the depressed portion, if sharply defined, resemble the edges of a perforation very much, especially since the latter are often partially adherent to the promontory.

Lateral illumination, turning the mirror in such a manner that we may see under the edge of the perforation, or throw a shadow upon it, but especially an examination after an air douche or bath in such cases, will assist us to form a correct diagnosis.

The membrana tympani, or as much of it as remains, is thickened throughout all its layers, not unfrequently

[1] Schwartze, A. F. O., I, s. 140.

it is partially calcified, and superficially covered by secretion, or at least infiltrated and dull in appearance.

According to *Politzer* these calcareous degenerations, or depositions, are to be considered, in the majority of cases, as the result of an otorrhœa that has run its course, where the exudation passing into the fibrous layer, from the adjacent ones, has undergone chalky degeneration. Even where the history of the patient does not speak of a discharge from the ear, we may often believe that one has existed, because very many can not remember an otitis that occurred in infancy.

The curvature of the membrana tympani is very often changed, so that individual parts are pushed backward and are adherent to the cavity of the tympanum. The borders of the perforation are usually reddened, of a roundish and distinct contour, and when they involve the center of the membrane, somewhat resemble a kidney with the hilus toward the handle of the malleus.

The handle of the malleus, at its lower extremity, is sometimes exposed and lies in the middle of the perforation. If the membrana tympani be for the greater part wanting, then only the uppermost portion of the handle of the malleus is to be seen. This, with the *processus brevis mallei*, as well as the outer border of the membrana tympani, almost always, remains, although it is often hard to recognize and distinguish it from the neighboring swollen tissue. In all the cases where the structure of the membrana tympani is perforated about the most concave portion of its concavity (or *Umbo*), the lower portion of the handle of the malleus, which is now deprived of its attachments to the membrane, lies deeper in the cavity of the tympanum.

In some cases there is very little swelling or hyperæmia of the exposed mucous membrane of the cavity of the tympanum, while in others there is a great deal. It is

generally covered with secretion at the lower part, which may be pushed outward through the Eustachian tube with a slight whistling sound. In cases where the whole cavity is filled with pus, and the hole in the membrana tympani is a small one, the patient can press the secretion through the perforation drop by drop, without the slightest sound. At the moment when the patient stops the pressure, the drop, which was at the time passing through the perforation, will fall back into the cavity of the tympanum. Occasionally the edge of the perforation, even when it contains no drop of fluid, pulsates with the motion of the heart. This is always the case when there is any pus or fluid on the inner surface of the perforation; and then the pulsation is doubly distinct, on account of the strong and glancing reflection of the drop.

Losses of substance occur in all parts of the membrana tympani, but most frequently anteriorly and below. They also occur in all possible dimensions. Very small ones, that only allow a small amount of light to pass through, appear black, almost like a spot of pigment on the membrana tympani. In larger ones the color depends upon the condition of the mucous membrane of the cavity, and the distance of the edges of the perforation from the points lying beneath. It is rare to see two perforations in one membrana tympani, but they do occur. Sometimes there is only a small bridge between the two, while again they are on very different parts of the drum. I once saw three different perforations on one drum. It was the case of a young patient with tuberculosis.

Such perforations occur by far the most frequently in the intermediate zone, so that the center, as well as the border of the membrane, still remain. Losses of substance close to the annulus tympanicus are extremely rare. In one case I saw a peripheral detachment of the whole

posterior half of the membrana tympani, by the formation of one extremely peripheral perforation below another. The bridge between them deliquesced, and thus the two were united. Another loss of substance suddenly appeared under this longish perforation, which enlarged in an upward direction, and then ran into the other. This was repeated several times, until within a short period the entire posterior half of the periphery of the membrana tympani was destroyed by suppuration, without any pain or other symptoms of irritation.

As a consequence of this deficiency in the membrana tympani, that part of the wall of the labyrinth—the promontory—lying opposite the lower and anterior portion of the membrana tympani is exposed, and even when the mucous membrane of other parts is not swelled, vessels may be traced running over it. We may often, also, distinguish the anterior edge of the entrance to the fenestra rotunda. The membrane of the fenestra, in consequence of the oblique position of the niche on whose border it is first attached, can not be distinguished, even if the whole of the membrana tympani be gone. If the perforation be in the posterior or upper part of the membrane, or if the greater part of it is destroyed, the long process of the incus is frequently wanting. If it be wanting, the connection between the stapes and the other

of the malleus is sometimes so much drawn inward by direct adhesion of its end with the promontory, and lies so nearly horizontally that it cannot be traced from without, and thus the observer is led to believe that the whole lower part is destroyed by ulceration.

The degree of hearing remaining in the above described conditions is very different in individual cases, reaching from total deafness to the ability to hear enough for the ordinary vocations. It depends greatly upon the amount of secretion and swelling. It is well known to you that a perforation of the membrana tympani by no means necessitates or involves a high degree of impairment of hearing, although you will often find an opposite view taken, not only among the laity, but also in the profession. Commonly, the hearing is so much affected in consequence of the perforation of the membrana tympani, that a watch which may be heard for six feet by a normal ear, can only be heard from one to two; but this leaves sufficient hearing for ordinary purposes. I know several persons with perforation of the membrana tympani on both sides, who are so little disturbed by it that they are not considered as deaf persons, or as even hard of hearing. Even a complete loss of the membrana tympani does not entirely destroy the hearing, although it must suffer severely therefrom.

It is not the hole in the membrana tympani that causes the most trouble to the hearing power, but the consequences of the inflammation which first caused the perforation. The most injurious of these consequences is the thickening of the mucous membrane of the ossicula, and of the fenestræ of the labyrinth. This may result from suppurative as well as from catarrhal inflammation. If a great amount of secretion still exist, the amount of hearing will depend to a great extent on the amount of secretion that has been collected on the parts that conduct

the sound. Hence, in such cases the hearing varies exceedingly at different times. In the case of a small perforation the amount of thickening of the membrana tympani also comes into consideration. The patients, therefore, hear better, as a rule, when the perforations are of medium size, than when they are very small, because in the former case the sonorous waves, avoiding the membrana tympani, malleus and incus, pass through the perforation directly upon the base of the stapes, and may thus reach the labyrinth to quite an extent. (Politzer.)

Each perforation of the membrana tympani must be regarded as of moment, and it has the following importance: the mucous membrane of the cavity of the tympanum thus loses its natural protection, and is open to atmospheric influences, and will be retained in an irritated condition, which may increase to an acute affection of more importance. Again, the existence of a perforation is generally the reason that a chronic otitis, with otorrhœa, often remains through the whole life of the patient, and can never be permanently healed.

Such forms of disease often run on for years without any further consequence than that the patient has a discharge from the ear, and is somewhat hard of hearing. This condition does not receive the amount of attention which it demands, especially if it be on only one side. The discharge varies at different times in degree and kind, and sometimes disappears altogether for a time. The surgeon is generally first called to see such a case when, after a cold or injury, an acute and painful condition is present. If we except those cases where important complications, such as ulceration of the bones, have occurred, the pain and other symptoms in such a sub-acute otitis interna are less than in a primary otitis; because, in consequence of the perforation in the membrana tympani, there is seldom any great amount of secretion in the cavity

of the tympanum, it being able to pass out, unless the opening is accidentally closed by a mass of epidermis or a thick scab.

If neglected and left to itself, chronic otitis interna may lead to the formation of polypi, to caries, and to various disturbances, of whose great importance for the life of the patient we shall speak more fully. We are often able, by proper and long-continued treatment, to bring such a process to a stand-still—to lessen the purulent discharge and hyperæmic swelling of the part; and we often, also, obtain with this a considerable improvement in the hearing.

Under favorable circumstances we are often able to completely cure recent affections, and sometimes even long-existing purulent catarrh of the middle ear, and to close the opening in the membrana tympani. To those who doubt that perforations of the membrana tympani will heal, I would like to adduce cases in my own experience, among which are those of two members of our profession. Some cases occurred to me where I was obliged to refer back to the history in order to see in what part of the membrane there was previously a perforation; so little trace of it remained. Where, however, the loss of substance was large, the cicatrix, or, more properly, the regenerated portion, can be distinctly seen, especially some time after the perforation has healed. I once examined such a healed perforation on the dead body.[1] In this case the microscope showed that there had been a loss of substance, and that a spot a little thinner than the remaining portion of the membrane was a cicatrix. In practice we may quite often see such cases on the living. The cicatrices are generally seen as thin, sharp-bordered, slightly depressed spots, which sometimes have a peculiar, diffuse, mother-of-pearl-like reflection, and which, on blowing in upon the membrana tympani, stretch out in

[1] See Virchow's Archive, B. 17, p. 16.

their full dimensions. Politzer has also shown that similar thinned spots may result from a partial atrophy of the membrana tympani in the course of chronic catarrh of the cavity, without perforation of the membrana tympani.

If a perforation should close, the patient will probably not hear so well immediately after; but we must not attempt to prevent the closure. If we open a freshly-healed perforation, the patient will hear better for the moment, but, on the other hand, if we leave the cicatrix alone until it becomes firm, the hearing will either gradually improve of itself, or from the introduction of warm air, or the injection of irritating fluids, just as in the treatment of chronic catarrh. This must not be attempted for some time after the perforation has healed, and then must be done with the greatest care, lest an otorrhœa be excited. The closure of the perforated membrana is the most desirable and permanent means of improvement, and our treatment should be directed to securing this end. We must avoid, however, lessening the size of the opening until we have bettered the condition of the cavity of the tympanum, and the mucous surface of the membrane, or we shall not have improved the state of things, but, on the contrary, have made it worse, because, by so doing, we have rendered the exit of the pus, as well as the entrance of the fluid for cleansing the ear, and that used as an astringent, more difficult. We must always remember that we are dealing with a fistulous opening, which will heal with very little aid so soon as the morbid condition of the fistulous canal is removed; but that we shall render the condition of things worse if we close the opening without healing the canal, because the accumulation of a mass of pus, with all its consequences, is thereby favored.

These cases were formerly described as "chronic inflammation of the membrana tympani, with perforation." A signification much too important and independent, was

thus ascribed to the condition of the membrana tympani, and the real starting point of the whole morbid process, suppurative inflammation of the middle ear was overlooked. In consonance with this nomenclature, attempts were made to heal the perforation by direct irritation of its edges, a method which could only be appropriate after a purulent inflammation had run its course. (*Gruber* advises a number of slight vertical incisions on the edges of the perforation in such cases.[1])

If we accept the view, however, that the persistence of a hole in the membrana tympani is a condition consequent upon a suppurative inflammation of the cavity of the tympanum, we should first of all attempt to cure the latter. We shall subsequently learn, in the detailed statement that I propose to make on otorrhœa, that we may thus secure a closure of the perforation, without having directly localized our treatment upon it.

An exception to this rule is formed by those cases where the perforation is maintained by partial adhesion of its edges to a portion of the cavity of the tympanum. Under such circumstances the healing of the perforation is sometimes secured by a mechanical separation of such adhesions, either by an operation, or by pressure from within, by means of the air douche, or by frequent exhaustion of the air by means of a gutta-percha tube passed into the auditory canal, or by the use of *Siegle's* pneumatic aural speculum. (See figure on page 286.)

The Artificial Membrana Tympani.

Historical.—In order to neutralize the evils produced both upon the hearing and the cavity of the tympanum, by a great loss of substance in the membrana tympani, attempts were made more than two hundred years ago to

[1] Bericht, 1866, S. 6.

construct an artificial membrana tympani by which the opening might be closed, and the portion that is wanting replaced.

Marcus Banzer[1] (1640), recommended for this purpose a tube of elk's claw, the end of which was covered by a piece of a pig's bladder. *Leschevin*, in 1763, also had an idea of an artificial membrana tympani. *Autenreith*, in 1815,[2] proposed to make an artificial drum from a short lead tube, with an elliptical opening, over whose inner extremity a bit of the swimming bladder of a small fish was placed, while wet, and varnished after drying. Linke[3] states that he has employed tubes most essentially in this manner, and with good result. He gives a sketch of the instrument.

Toynbee, in 1853, proposed to use such an artificial membrana tympani, without, as it seems, knowing of the previous suggestions of a similar contrivance. It consists of a thin disk of vulcanized rubber, in the center of which a fine silver wire, a little more than an inch long, is attached, which terminates in a little ring by which the instrument can be readily removed.

A mechanic in Nurenberg makes these instruments with an improvement on the method of attachment. The wire is inserted in the disk

Fig. 34.

Artificial membrana tympani.

[1] Disputatio de auditione læsa, Wittebergæ, 1640, Thes. 104.
[2] Tübinger Blättern, B. I, St. 2, s. 129.
[3] Hanbuch der Ohrenheilkunde, 1845, B. II, s. 446.

spirally, like a cork screw into a cork. It is thus rendered less liable to detach itself from the rubber and be left behind in the ear, an accident which quite often happened with Toynbee's instrument.

Since this silver wire may very readily come in contact with the auditory canal, and cause, especially in eating, a very disturbing noise, *August Lucae*, of Berlin, uses instead of it, a little rubber tube of about an inch in length, and of two mm. in diameter, which is fastened to the disk of rubber by a solution of gum arabic. This latter instrument is introduced by means of a metal or wooden probe passed into the tube.

Such an artificial membrane is pressed against the remains of the natural one, and sometimes causes a truly magical effect upon the hearing. I have seen cases where conversation could not be heard unless the voice were elevated in close proximity to the ear, so much improved that, some steps off, each softly spoken word could be repeated by the patient. In cases where the perforation is very small, and very much of the membrane remains, the artificial membrane often causes too much irritation. Its use cannot be continued for any considerable time when there is any evidence of recent inflammatory action, or any great amount of suppuration.

Some patients only introduce it at times when they wish to hear particularly well. It must be considered a rule that the instrument, in the beginning, can only be worn for a short time, and that it is always to be taken out of the ear at night.

Frequent cleansing of the ear, and the regular use of astringent ear drops, are the more necessary when this instrument is used, because the secretion will be increased by the presence of a foreign body. The cases are, however, very frequent, where a long-continued use of such an apparatus is of no advantage, and where the patient is,

on the whole, more benefited by the lessening of the suppuration than by the use of such an instrument.

We can never tell beforehand whether the instrument will do any good or not, and we must seek by repeated attempts to find the position where it improves the hearing the most. In what manner the benefit, which is often marked, from the use of the artificial membrana tympani occurs, we cannot exactly say as yet. It seems to me that there are various ways in which it may do good.

According to *Lucae*, it improves the hearing because the fluid of the labyrinth is brought under a greater pressure. Besides, such a disk of rubber acts as a vibrating plate, which may be able to carry a considerable number of vibrations upon one of the ossicula. (*Politzer.*)

Fig. 35.

Method of applying artificial drum. (Toynbee.)

It is certainly seldom beneficial from the mere closure of the cavity of the tympanum, an explanation by which

Toynbee seeks to explain the improvement in the hearing attained by it. It often improves the hearing when its edges are so folded and everted that there is no perfect closure of the cavity, and even if a portion of it be cut off. In all cases the improved condition of the hearing is accompanied by the advantage that the mucous membrane is guarded from the effects of the atmosphere, and I often use the gutta percha for this purpose alone. In such a case the silver wire may be shorter, for it is not necessary that it should be introduced so far as to rest upon the remains of the membrana tympani. That the improvement in hearing by the use of Toynbee's instrument did not depend on the closure of the cavity, I was able to prove in one case of a very small opening which I closed by the use of collodion, without benefit to the hearing. It was immediately improved, however, by the introduction of the disk of gutta percha, or when any other firm body was pressed upon the remains of the drum.

In the most cases it seems to be the pressure on the membrana tympani, and on the handle of the malleus, which causes this sudden and wonderful improvement. This opinion is sustained by the fact that the same effects which are obtained by the introduction of Toynbee's instrument are produced by the use of a little ball or wad of moist cotton, which is pressed on a certain part of the drum. *Yearsley*, of London, in 1848, first recommended this procedure. The cotton wad is to be preferred to the gutta percha disk where the latter proves irritating, or when a considerable purulent discharge exists.

(The use of this cotton drum was first suggested to Mr. Yearsley in 1841,[1] by a patient from New York, who had been in the habit of using a bit of paper moistened with saliva, with great benefit to his hearing. St. J. R.)

By the use of an astringent with the cotton the sup-

[1] Yearsley on Deafness, p. 221.

puration may often be diminished. Many patients are able to place the cotton on the right spot with the aid of a forceps, after a few attempts. In patients who are less intelligent, the disk of gutta percha is to be preferred, because it is easier to introduce, and when it is misplaced it may be readily brought into a proper position.

We can imagine various changes which would be likely to occur from the pressure of this foreign body on the membrana tympani and the handle of the malleus.

We remember that in a purulent inflammatory process, especially, there is apt to be a solution of the continuity of the *ossicula auditus*. This occurs most commonly in the articulation of the incus and stapes, whether it be by simple loosening of the soft capsule of the joint—a sort of luxation or disarticulation—or by means of a loss of the long process of the incus, which, as we have seen, is sometimes destroyed by caries. When the membrana tympani, with the incus, is pressed against the stapes by a foreign body, the continuity will be restored.

O. Erhard, of Berlin, author of the Rationelle Otiatrik (a queer book), claims to have been the first to discover the method of curing deafness by pressure on the membrana tympani in his own ear, and to have published it in 1849, without knowing of the claims of Yearsley.

These morbid changes, affecting the little bones of hearing, which would seem to be so seldom, are not as rare as we would naturally think. In Toynbee's catalogue of preparations of the ear, among the great number of sections which he has made, the entire loss of the incus occurs four times. Its long process was wanting ten times, partially or fully, and in fifteen cases the articulation between the incus and stapes was lost. I myself found the last state of things three times on the dead body. In one case I was not able to get out the bones till eight days after death, and the separation which occurred may have

been only macerative, the cavity of the tympanum being filled with pus. The other cases can not be thus explained, for there was no injury done in opening the cavity. Such a separation of the very delicate connection between the incus and stapes may occur during life from a severe concussion of the head, and especially by means of a sudden change in the pressure of the air in the middle ear, just as a laceration of the membrana tympani may occur from the same cause. Recall to your mind what we observed in this respect in our observation of the physiological importance of the mastoid cells. Collections of purulent exudation may also produce such a result by ulceration, and the whole chain of bones may suppurate and pass out. Further, a gradual or sudden bursting of the delicate membrane may occur by means of a strong expiratory effort, or of itself, when a spurious anchylosis, by means of adhesive bands, has rendered the parts inflexible. The last named condition obtained in my cases, and in a number of those of Toynbee.

Politzer uses a bit of hard rubber from four to five lines long, and one and a half to two thick, fastened to a simple wire, for the purpose of an artificial drum, in practice among poor patients. In cases where the stapes is absent, he fastens one taken from the cadaver to the artificial drum.

As the separation between incus and stapes is by no means always a result of purulent deposits in the cavity of the tympanum and perforation of the membrani tympani, so the improvement in hearing by pressure on the membrana tympani may occur in persons where the membrane is entirely uninjured. I have seen one such case, where the introduction of a little wad of cotton improved the hearing for one day in a remarkable manner, and in the recent and ancient literature, you may find numbers of cases related, where patients, hard of hearing, have accidentally found,

that by the introduction of a foreign body in the ear they could temporarily hear better. As such assistances to the hearing, all possible things have been used — pencils, chewed paper, shavings, onion bulbs, lint, etc. One of the most interesting of these cases is related by *Menière*, a distinguished and excellent otologist.[1]

A deaf old judge had been accustomed for at least sixteen years, by pressure of a blunt gold needle against the membrana tympani, to produce for himself, for an hour or so, a tolerably good hearing-power. *Menière* examined the ear during such a period. He found the membrana tympani uninjured, and that the pressure was made upon the handle of the malleus, which was pressed somewhat inward. He speaks of having seen several similar cases, and considers them cases of nervous deafness, which were improved to a certain degree by pressure upon the ossicula auditus, and through them on the labyrinth.

(I have thought it proper to insert the notes of a few of the cases of the use of the artificial drum which have occurred in my practice,[2] with some remarks upon the requirements to be fulfilled in attempting to employ this instrument.

CASE I. *A farmer, aged* 30, *from Michigan. Jan.*, 1865. The patient had scarlet fever thirteen years ago, since which time he has suffered from periodical attacks of pain referred to the ears, discharge of pus from them, and vertigo. He has also been so deaf as not to hear ordinary conversation, ever since the attack of scarlatina. Patient's general condition is bad, he having suffered much from intermittent fever. He cannot hear a watch at all, which should be heard by a person with normal hearing power, more than four feet, neither on auricle, mastoid process, nor frontal bone. The right membrana tympani has been wholly removed by ulceration; no trace of *ossicula auditus*. Mucous membrane of the cavity of the tympanum hyper-

[1] Traité des Maladies d'Oreille, par Kramer, traduit par Menière. Paris, 1848, p. 526.

[2] American Journal of the Medical Sciences, Vol. LI, p. 106.

rophied. A portion of the periphery is all that remains of the left membrana tympani. The incus and stapes remain in situ, but the malleus has been lost. Mucous membrane of the cavity of the tympanum also hypertrophied. Both Eustachian tubes are pervious, as proven by the Valsalvian experiment. The artificial membrana tympani was placed in the right ear without producing the slightest benefit; being inserted in the left, it immediately so improved the hearing that the watch could be heard two inches from the auricle, and ordinary conversation several feet. The patient was enabled to pronounce isolated words after a speaker who stood more than twelve feet distant. The patient was under observation for a few days, during which time the hearing remained as good as above stated. He then left for his home, taking with him a supply of the artificial membranes.

CASE II. *Miss U., aged* 30, *New York. May* 31, 1865. Patient has been deaf ever since she can remember. Does not hear conversation unless specially addressed, and then the voice must be raised. She knows no cause for the deafness. Hears the watch two inches from the right auricle, not at all on the left side, except upon the mastoid process. Left membrana tympani opaque in its mucous and fibrous layers. The light spot is lessened in size, and the head of the malleus is abnormally prominent. Right membrana tympani perforated by ulceration in center, the remaining portion is granulated. A very slight amount of greenish fetid pus is secreted by the cavity of the tympanum and the remains of the drum. The pharynx is congested. Eustachian tubes impervious, as shown by the Valsalvian experiments, Politzer's method, and the catheter. General health not good, although no especial disease is recognized. Patient was seen every few days until August 5th, during which time the following treatment was carried on: Permeability of the Eustachian tubes was secured by the use of the catheter and Politzer's method, together with the use of gargles, and a weak solution of sulphate of zinc (gr. j., ad. aq. ℥j.) was applied and worn, except at night. It caused at first much irritation and furuncular inflammation. The artificial drum was removed until this was checked. The drum is now worn all day, and the watch is heard from six to eight inches with it, only two without it. Ordinary conversation heard fairly; hearing on the other side as before. Patient expresses herself as being very much improved.

CASE III. *J. J. V. P., aged* 28, *Louisiana. Aug.* 12, 1865. Three years ago, while in the artillery service, patient lost his hearing gradually, although he remembers, at one particular time, after being engaged in heavy firing, that he had a distinct sensation in the right ear, after which he was deaf from that ear for some time. The ears were treated, by the medical officer of the regiment, by the application of tannic acid. He continued in the service until the end of the war, and was subjected to various kinds of treatment, application of arg. nit., cup. sulph., and other astringents. At times he could hear quite well, and then his ears were "stopped up" for a time. He was exposed to much hardship during a great part of his term of service. The deafness has increased until now, when he can not hear at all from the right ear, and from the left with the aid of an ear trumpet. He does not hear the watch at all on either side. The right membrana tympani, except as to the upper portion, where a small rim remains, has been removed by ulceration. The integument of the auditory canal, and the mucous membrane of the cavity of the tympanum, are hyperæmic and swollen. The little bones of hearing cannot be found. There is a slight amount of fetid pus secreted by the mucous membrane. On the left side the auditory canal is extremely hyperæmic, swollen, and tender. The epidermis is exfoliating. The membrana tympani is not seen, but the Valsalvian experiment shows that it is perforated. Both Eustachian tubes are open.

October 18. Since the first date the patient has been seen twice a week, and has been treated in the following manner: The ears have been gently syringed with warm water twice a day, a weak solution of the sulphate of zinc (gr. ss. ad. ℥j.) has been dropped into the auditory canal and cavity of the tympanum, always warming it before use, and injections of the vapor of iodine have been made into the middle ear by means of Politzer's method for rendering the Eustachian tube pervious. The condition of the patient's ears is now as follows: On the right side the hyperæmia and swelling are reduced to a minimum, as also on the left. In the left cavity of the tympanum the incus in position can now be distinctly defined. On this side the artificial drum is worn by day, except when the patient is alone for some hours, and removed at night. On the right side the drum has been worn at times, but never with any appreciable change as to the hearing power, which remains as when patient first came under observation, except that he can now hear the alphabet pronounced through

an elastic tube. On the left side he can hear the watch over the auricle, and ordinary conversation near at hand with ease. He can hear a sermon in church, and goes once more into society, from which his previous amount of deafness completely excluded him. He does not use an ear trumpet at all, hearing better without the drum than he did formerly with the aid of a conductor of sounds. The patient is extremely intelligent, and to his strict attention to the directions given — his careful use of the artificial drum, removing it whenever it has caused the slightest irritation — a great part of the modicum of success attained is due.

CASE IV. *Miss N., aged* 18. *July* 18, 1865. One year ago was quite ill; the nature of the affection can not now be accurately ascertained. During the sickness both ears began to discharge pus, and deafness appeared. The discharge was checked, but the deafness has gradually increased until now, when she can not hear ordinary conversation, and hears the watch only one inch from the auricle. Each membrana tympani has a central perforation, and there is a slight amount of yellow fetid pus secreted in the cavity of the tympanum. The Eustachian tubes are pervious. The artificial drum improves the hearing on each side, by the watch, to a distance of six inches, and renders ordinary conversation easily heard. The patient was directed to daily syringe the ears with tepid water, using afterward an astringent, and to wear the drum during the day. Patient has come to the office very irregularly, and carried out the directions very inefficiently. She seems to have an aversion to the use of the the drums, wishes to be cured without wearing them. They cause considerable irritation of the auditory canal.

CASE V. *Rachel C., aged* 16. *April* 1, 1865. One year and a half ago patient discovered that she did not hear well. The deafness still continues, with some occasional pain and noise in the ears. She can hear the watch three inches from the right ear, one inch from the left. There is a perforation of each drum, with a slight ulcerative process going on in the membrane. Patient is of a strumous diathesis, has a curvature of the spine, but is just now in fair general health. Careful syringing of the ears, followed by the use of an astringent, was directed. There is no account of the condition of the Eustachian tubes until June 8, when *Dr. C. E. Hackley* inserted

by the fact that it is developed in so many different diseases of the ear, and because it is generally left to itself, and therefore lasts a great while.

Otorrhœa is generally considered of no particular importance, both by the laity and the profession, and thus it comes to be neglected. Sometimes it is even thought that the health would be injured by an attempt to check the discharge.

In opposition to this general opinion, I have often, in the course of our meeting together, called your attention, not only to the importance of every discharge from the ear, for the affected organ, but also for the general condition and life of the patient. In this last-named view we shall now consider otorrhœa, and the more minutely, since the importance attached to the subject, especially in Germany, is exactly the opposite from that which it requires. (This is also true of the United States.)

Suppurative inflammation of the soft parts of the external and middle ear, can not be regarded with indifference, because it may easily produce inflammatory softening of the bones, to caries, and because the anatomical relations of these parts are very favorable to those morbid processes that lead to the well known embolic and septic diseases.

Caries of the temporal bone very rarely depends upon a primary affection of the bone, but it is generally developed in the course of an otorrhœa that has existed for a long time, especially if it has been badly treated, or perhaps not treated at all. As we have already seen, the periosteum of the auditory canal, and of the cavity of the tympanum, are in the most intimate relation with the cutis or mucous membrane which lies over it. Hence severe disturbances of nutrition of the soft parts must almost necessarily lead to affections of the bone beneath. In every otitis externa and media, if the suppuration be not

gradually checked the bones must take more or less part in the inflammatory and ulcerative process.

Carious affections, on whatever part of the body they may occur, as is well known, are generally considered by the profession, as very important, not only because they may excite great local destruction, but also because they may bring the life of the patient in the greatest danger, either from the blood poisoning or emboly which may result, or from the condition of debility or degeneration of internal organs to which they lead.

Caries of the bones of the spine and cranium is particularly dangerous. No bone of the cranium becomes carious so frequently as the temporal bone. In connection with the peculiar structure of this bone, there are some unfavorable conditions that come especially into consideration, and that cause its affections and with them the point of origin, suppurative inflammation of the soft parts, and otorrhœa, to appear in a very dark light, as far as a prognosis is concerned.

I have already called your attention to the short distance of the dura mater and the cerebrum from the upper wall of the external auditory canal, and also to the proximity of the transverse sinus, and of the mastoid cells, to the posterior wall. This proximity explains why these parts are sometimes involved in the inflammation, even when the caries is confined to the auditory canal. The anatomical relations are still more important in the cavity of the tympanum, since its lower wall, or floor, is frequently separated from the jugular vein only by a thin, translucent layer of bone. Again, the largest artery of the head, the internal carotid, with the venous sinus surrounding it, takes its course, on its anterior portion. These are separated from the cavity merely by a delicate and frequently defective bony lamella. Furthermore, its roof, or upper wall, which with the superior petrosal sinus lies

between the mucous membrane and the dura mater, is not unfrequently thinned and even perforated, and besides, even in adults, there is usually a gap in the bone—the petro-squaumosal fissure.

The inner or labyrinth wall, finally, offers only slight resistance to the transition of the inflammation to the facial nerve, and through its two fenestræ, which are only closed by membrane, to the internal ear, and then to the meatus auditorius internus, which is covered by the membranes of the brain. Close under the mastoid process, which is intimately connected to the cavity of the tympanum, is the transverse sinus, which makes up the whole of these important relations.

Now, I ask, gentlemen, if you know a small cavity in the human body, borders in a similar manner upon so many important organs, and in which we should, therefore, so anxiously regard purulent processes and their common consequences? However, we do not speak here from a merely theoretical stand-point, but our practical experience shows us, and every surgeon knows, that caries of the bones of the ear very often excites affections that are dangerous to life.

Inflammation of the brain substance, the formation of abscesses in it, and purulent meningitis, accompanied by changes in the structure of the upper wall of the cavity of the tympanum, have been observed to be the most common of the effects of caries of the temporal bone. According to *Lebert*,[1] who has called our attention to the frequent connection of abscesses of the brain with affections of the ear, about one-fourth of these abscesses have their origin in caries of the petrous portion of the temporal bone.

If we look at the cases of abscesses in the brain, scattered here and there in the literature of aural surgery, we shall find that aural affections, in perhaps half of the cases,

[1] Virchow's Archiv. B. X.

have been the cause of cerebral abscesses, and there is an urgent necessity in every such case to follow *Lebert's* advice, and carefully examine as to disease of the ear. As a rule, there will be found healthy brain substance between the external surface of the petrous bone and the purulent masses in the brain, and the dura mater on the *tegmen tympani* (a thin plate of bone forming the upper wall of the cavity of the tympanum) is considerably thickened. Much more rarely the deposits of pus run into each other, and thus have the appearance of being metastatic.

This is not the place to go any further into the symptoms of abscesses of the brain. I would only remind you of the great changes that may take place in the brain, unaccompanied by fever, and with no disturbance of the functions, especially of the intelligence. Severe local pain, increasing on pressure, is often for a long time the only symptom of an otherwise entirely latent affection of the brain, and death sometimes occurs very suddenly and unexpectedly with convulsive or apoplectic symptoms.

(At the meeting of the New York Pathological Society, held January 23, 1860, Dr. T. G. Thomas presented a specimen of abscess of the brain, resulting from otorrhœa, the history of which I condense somewhat and insert here): "A girl about fourteen entered Bellevue Hospital on Monday, January 23; the general health had been good, except that she was subject to an occasional slight otorrhœa and convulsions, which were clearly of an hysterical nature, which had existed for a year. On the seventeenth of the present month, she was seized with a violent pain in the ear, which ceased on the twenty-first, and pus was discharged.

"Headache complained of, and pain along the course of the spine; vomiting and occasional delirium set in; convulsions continued.

"She died in a few days, and the diagnosis between profound hysteria and abscess of the brain was not established till the post mortem.

"Abundant traces of pus were found at the base of the brain. At a point just above the petrous portion of the temporal bone there

were fluctuations, and about one drachm of pus was
incision, pus was found on the outer surface of t
evidently resulted from local meningitis."

"Dr. Bibbins referred to a case which he saw wh
Island Hospital: A little child had otorrhœa with m
plegia. The doctor noticed a suspicious purplish ap
the ear, which looked as if some portion of the mast
about to exfoliate; the child was doing well, not c
was suddenly seized with a convulsion and died.

"Post mortem showed a large abscess of one l
bellum."

My friend Dr. R. Hubbard, of Bridgeport, once tol
seen several cases within one week of practice. Th
of their frequency. Almost every practitioner has s
Four have come under my personal observation, c
detailed elsewhere in this book.)

Otitis and otorrhœa quite as often lead
pachymeningitis; and here the anatomi
allowing the transfer of the affection, is com
and less doubtful, than is the case in cere
The inflammation of the cavity of the ty
extend in two ways upon the coverings of th
through the tegmen tympani, that is, upward
through the meatus auditorus internus.

Inflammation of the roof of the cavity of th
and consequently of that part of the dura ma
by far the most common result of suppurat
of the ear, as is shown by post mortem se
may depend, in good part, on the fact that
of the base of the skull and its changes, n
seen in an examination of the dead body, whi
morbid appearances must be carefully loo
removal of the temporal bone. We may th
they really occur most frequently in this
whether they are only most often discovered.

Some anatomical peculiarities of the roof

of the tympanum may explain the transition of inflammation in this direction.

I recall to your mind the fissure in the bone which exists here, and to the arterial branch, and the process of tissue which pass through this fissure from the dura mater to the mucous membrane of the middle ear, and by means of which, each nutritive disturbance in the cavity of the tympanum and mastoid process will exert a certain effect on the dura mater. I may also remind you of the thinning, or rarefaction of the bone, which we have found to be quite common here, and which may thin the *tegmen tympani* even to perforation, without any declared caries of the bone. It is clear that in a case where there is very little, or, perhaps, no substance intervened between the mucous membrane and the dura mater, an extension of the inflammation may very easily occur, and that the gas evolved from such a purulent mass will be especially injurious to the tissue lying over it.

The cases, where an otorrhœa, which has existed for years, has ended fatally, under the form of meningitis, while the roof of the cavity of the tympanum was not attacked, but the disease had extended from the internal auditory canal, occur very often in surgical literature. Very often, however, an exact anatomical description of the intervening parts is wanting. In the cases which have been carefully examined, the inflammation and purulent discharge extended from the middle ear to the labyrinth, and thence upon the meatus auditorus internus. The wall of separation between the middle and internal ear — the labyrinth wall of the cavity of the tympanum, is thin of itself, and contains two fenestræ, vulnerable points, through which extension of morbid processes is very easy. *Itard*[1] speaks of such a case; and I can show you another where the delicate annular ligament about the base of the stapes was affected and thus the

[1] Traité des Maladies de l'Oreille. 2 Ed, 1842, Tome i, p. 210.

purulent process found its way into the labyrinth. There are also many other preparations illustrating this point, especially those of Toynbee. If once the vestibulum and cochlea be affected, there is nothing between the inflammatory mass and the meninges, but a finely permeated lamella of bone, through which the auditory nerve sends its soft, hair-like threads into the labyrinth, and thus, in the majority of cases, when the labyrinth is invaded, the process extends to the coverings of the brain.

There is still, however, a third way in which a continuation of a purulent inflammatory process may be continued to the cranial cavity.

It is well known to you, that occasionally inflammations extend from one point to another along the course of a single large nerve twig, under the form of a peri-neuritis, an inflammation of the sheath of the nerve. A continuation of an inflammatory action may thus extend from the cavity of the tympanum, even when the integrity of the labyrinth is perfect, through the Fallopian canal along the facial nerve, and so much the more, since this nerve is very often involved in the affection. To my knowledge, no such connection between otorrhœa and meningitis has previously been observed. In a similar way the pathological condition may be transmitted along the connective tissue of the vessels and the nerves, to the most different parts of the ear.

The anatomical considerations of the parts show us that the facialis must be often affected in otitis interna. Sometimes the facial nerve runs for a considerable distance on the wall of the cavity of the tympanum, and is only separated from its mucous membrane by a thin, transparent lamella of bone. Sometimes, again, the stylo-mastoid artery, which supplies the greatest part of the membrane of the middle ear, takes its way through the Fallopian

canal, and gives off branches to the sheath of the facial nerve.

Facial paralysis, of various grades, often following spasm of the muscles of the face, occurs not unfrequently in the course of an inflammation of the ear. Perhaps some cases of the so-called rheumatic facial paralysis, on more exact examination, will be found connected with affections of the cavity of the tympanum. Experience teaches us that the prognosis of this affection is not so unfavorable as it is often said to be, even in our best text-books of nervous diseases. Even very extensive facial paralysis disappears under treatment, if we are able to bring the process in the ear to a stand-still. I have seen quite a number of recent cases of one-sided facial paralysis fully cured by means of the simple treatment employed in chronic otitis. (I may be permitted to confirm this observation by my own experience. St. J. R.)

Moreover, we see from the described anatomical conditions, that the appearance of paralysis of the facial nerve, in the course of an otitis, by no means involves danger to the life of the patient, for we cannot, therefore, conclude that the brain is taking part in the affection. Great interference with the circulation and increase of secretion in the cavity of the tympanum, may be reflected upon this nerve. Caries itself, of the soft lamella of bone behind which the nerve runs, which will certainly excite facial paralysis, is by no means a very important matter, if it be not connected with more important changes.

The symptoms of facial paralysis are well known to you. The first indication of its existence is, that the patient does not drink properly, and that the fluid escapes at the angle of the mouth, as in an awkward child; still more commonly the patient suddenly notices epiphora in one eye. This last-named symptom is almost always the first

one complained of, and the carrying off of the tears, which, as you know, is accomplished by muscular action, is imperfectly accomplished even when the lids close exactly, and when there is not the slightest turning outward of the lower lid, and consequent displacement of the lower canaliculus.

Paralysis of both sides seems to be quite rare. I saw one case in connection with aural polypi on each side. The deformity was very remarkable. The face remained smooth, regular, cold, and without expression in laughing or crying; the under lids with greatly reddened edges were everted, while the cornea was very prominent and dry from want of covering; the thick swollen under lip hung down, allowing the saliva to drop out of the mouth, so that the chin was usually bound up with a handkerchief, and if the patient wished to speak or eat, he was obliged to hold it up with his hand.

I have already called your attention to the fact, that an oblique position of the uvula, and an abrupt bending of it to one side, while it is also somewhat drawn up, may be often observed without any paralysis of the face; while in well-defined facial paralysis the position or elevation of the uvula may not be affected at all.

We must finally mention that destruction of the walls of the vessels in the case of caries of the ear, often causes

An extremely interesting case of hemorrhage from the transverse sinus, through the nose and ear, was described by *Koeppe* in the Archives for Aural Surgery.[1] The connection, in this case, between the cavity of the tympanum and the sinus did not occur from actual caries, but from atrophy of the bone, the result of pressure. The passage outward of the secretion constantly forming in the cavity of the tympanum was prevented by polypoid granulations, and downward by swelling of the mucous membrane of the tube. "From the cavity of the tympanum, thus shut off, a cyst, as it were, arose, whose interior membrane secreted a puriform material, which gradually increased, exerted a constantly increasing pressure from within, and caused the bony wall to disappear."

All these various forms of disease that we have been studying as frequent consequences of caries of the petrous portion of the temporal bone, may, however, perhaps with the exception of destruction of the walls of the larger vessels, arise from suppuration of the ear, even without an affection of the bone, simply through morbid processes within the vascular apparatus.

Very many observations have long since rendered it quite certain, that otorrhœa very often leads to fatal disease, when no trace of caries of the bones of the ear is found in the cadaver. In order to explain this fact, we must remember that the lining membrane of the auditory canal and the cavity of the tympanum, that is, the tissue from which the suppuration in the ear takes place, has the same nutritive importance to the temporal bone that the peri-cranium—the outer covering of the skull—has for the other bones of the cranium, and that the vessels of the peri-cranium, by means of the diploë, are connected to those of the endo-cranium, that is, to those of the dura mater.

The diploë, therefore, with its partitioned cellular spaces, is a connecting link between the soft parts of the ear on one side, that is, the purulent collection, and the

[1] A. F. O., II, s. 181.

dura mater, with its venous sinuses on the other, since the venous net-work of the diploe not only obtains its blood supply from both sides, from without and within, but the larger osseous veins proceeding from it, the *venae diploïcae*, also empty in part into the external veins, and in parts inwards into the sinuses.

You will now comprehend, that, in consequence of inflammationof the soft parts of the ear, disturbances of nutrition in the dura mater as well as in the walls of its vessels — meningitis, as well as phlebitis — may easily occur. But that affections of the walls of the veins may cause further morbid processes within the vessels, which may lead to continuous morbid processes in the channels of the blood, is sufficiently well known to you.

We may often seek for the point of origin of various constitutional affections — which declare themselves under cerebral, typhoid, and pyæmic symptoms, and which appear on the post mortem table as metastatic abscesses and deposits, and as ichorous inflammation — in the most different structures, in the diploë, and in the other cellular portions of the temporal bone.

Surgeons have always known that even a seemingly trivial injury of the hard or soft parts of the head is to be seriously regarded, because it often leads to abscesses and inflammations in remotely situated organs, which may have a fatal result. At a very early period it was known that this was due to a certain participation of the diploë in the affection. Now, by means of the labors of *Virchow*, which have broken an entirely new way in the field of science, and made, as it were, an epoch in pathology, we know that next to the veins of the lower extremity, and of the pelvis, there is no part of the human body so favorably circumstanced for the formation of blood-clots, as the blood-vessels of the dura mater, and the net of capillary vessels communicating with them, which pass through all the cellular

structure of the bones of the skull, filling them, and thus making them very vascular organs. It is very plain that such a formation of plugs of fibrinous material, will be very much favored by inflammation of the diploë, such as easily results from the disturbances of nutrition of the adjacent soft parts of the ear, that are in immediate vascular connection.

The importance of osteo-phlebitis of the diploë, which is so greatly feared by the surgeon, depends for a great part on the action of purely mechanical causes. The vessels of the diploë are, in many places, if not everywhere, adherent to the unyielding bony wall, and thus, in consequence of hindrance in the contraction of the vessels, thrombi, plugs of fibrinous material are more easily formed in them, which extend into the sinuses by further growth, are then more fully developed, are finally carried forward, and having become wedged in the current of the pulmonary vessels, excite metastatic inflammation there.

In such cellular spaces as those which surround the auditory canal and cavity of the tympanum, purulent masses are apt to remain, deliquesce, and frequently lead to extravasations and subsequent coagulations of blood, which again act upon the contents of the sinuses, through the larger osseous veins. They also cause the development of real infectious masses, which pass into the circulation and excite the well-known pyæmic and septic metastases in the pleural and articular cavities.

If, however, more exactly speaking, a great part of the hollow and reticulate spaces of the temporal bone are not, in adults, to be considered as diploëtic, since they contain air, and do not enclose a thin fluid medulla with a minute vascular net-work, still we have here, when inflammations and suppuration occur, anatomical conditions very similar to those in diploëtic structure, and the cavities of the temporal bone, especially in the existence of perforation

of the membrana tympani, are in free connection with the atmospheric air. This connection, of course, favors the deliquescence as well as coagulation of blood in the injured vessels. The petrous bone of the child, however, consists almost entirely of diploë.

In England, it was long since time shown, that patients suffering from otorrhœa, die in consequence of purulent pleuritis, with pyæmic symptoms, and with lobular abscesses of the lungs, and that phlebitis of the cerebral sinuses of the jugular vein was an explaining accompaniment. Lebert first called our attention in Germany to these common results of inflammation of the ear,[1] and he attempted to show the deleterious influence of phlebitis on the blood channels, since, from them the inflammation must extend to the membranes and to the brain, or to the jugular vein and the lungs.

According to Lebert, inflammation of the venous sinuses first declares itself by a chill which suddenly occurs in the course of an otorrhœa, in connection with other symptoms of an incipient typhoid fever. Generally such cases are considered as true typhus. The pain in the head is much severer, however, it is confined to one side, and is increased on pressure. There is often delirium, appearing, like the pain at intervals, and varying with the symptoms of cerebral depression. In the same manner the symptoms of

death in the form of meningitis, distinct pyæmic symptoms appear in the course of the second or third week. The chills have so distinct a character, that many physicians diagnosticate the affection as intermittent fever, but a regular interval never appears, while the typhous exhaustion, the cerebral symptoms, and the remarkable weakness of the pulse continue, and gradually the symptoms of metastatic abscesses in the lungs and joints appear; sometimes they appear also in the subcutaneous connective tissue. In the first stages of the disease there is a tendency to constipation; later on, diarrhœa occurs; the evacuations are irregular, and death, in a comatose condition, generally occurs.

The course of this disease is either a rapid and acute one — which we might call the meningitic, because the cerebral symptoms are most prominent — or it is of a typhoid and pyæmic character, malignant to the highest degree, lasting to the fourth or fifth week.

Virchow has taught us, since then, that the putrid material in the blood — and not the inflammation of the walls of the veins, the phlebitis, although of course assisted by this — is the chief cause of the disease. I have thought it well, however, to give *Lebert's* description of the course of the disease in full. It must be clear to you that these consequences of otorrhœa, thus described, and whose origin may be referred to emboli and septic infection, that is, to morbid processes in the circulatory system, may appear without any caries of the temporal bone.

You will often, especially in the French authors, for instance in the works of *Rilliet* and *Barthez* on Diseases of Children, read of tuberculous caries of the petrous portion of the temporal bone, as a common cause of otorrhœa, which leads to a fatal result under the name of pyæmia or meningitis, especially in children. In the

post mortem examination we find tuberculous deposits in the ear in great masses, and encysted tubercle in the mastoid process: "*Matière tuberculeuse infiltrée ou encystée.*" The whole inflammatory process, the ulceration of the membrana tympani, the otorrhœa, with all its results, were considered as resulting from the softening of the tubercle, which was regarded as the primary process.

In a more exact examination the most of these cases have another signification. There is certainly a tuberculosis of the bones, and we cannot deny the possibility of a tuberculous affection of the temporal bone; yet the occurrence of such an affection is very rare. We must recollect that thickened pus and softened tubercle resemble each other very much. You know, gentlemen, that wherever pus is collected in any great mass, it becomes thickened and partially calcified, because the great amount of the substance does not allow of its complete breaking up and resorption. At the most, a part undergoes fatty degeneration, the remainder is calcified and the thickened pus then forms a cheesy mass, such as may be also developed from tubercle. These cheesy masses, of entirely different origin, are very often confounded, and to the unassisted vision they are scarcely distinguishable. Exactly here—in the cavities of the auditory apparatus, and in the cellular spaces of the mastoid process—are found large masses of pus, which gradually shrink up and form a cheesy-like substance; and perhaps the most of the cases designated in the literature as tubercle of the temporal bone are such deposits, which owe their origin to a long-continued and purulent inflammation, and their undisturbed formation, to a rare use of the syringe.

Dr. Zaufal[1] describes a case of "primary tuberculosis of the petrous bone," in a patient who died of phthisis pulmonalis. The tuberculous mass was embedded in the dense bony structure of the

[1] Archiv für O., II, s. 174.

anterior surface of the pyramid, and was not connected to the cavity of the tympanum, the cells of the mastoid, nor the cavity of the labyrinth.

However, even if such formations are not tuberculous, they have a very pernicious importance, as well for the neighboring parts as for the whole organism. It is well known also that these cheese-like masses sometimes soften and produce an ulcerated condition, from which, according to Professor Buhl's observations, acute miliary tuberculosis of the lungs and other organs may be developed.

I have observed that a comparatively large number of the very many persons suffering from chronic otorrhœa, that I have kept under my eye, went into a state of general decline, and died quite quickly in the best years of life. Acute tuberculous meningitis, tuberculosis of the lungs, or of the intestines, was generally found in those cases that were examined after death. In publishing three such cases in Virchow's Archives, some years ago, I felt compelled to ask, "If some forms of tuberculosis beginning suddenly, and having a speedy course, might not depend on an infection of the blood from some purulent collection." As I afterward learned, *Professor Buhl*,[1] of Munich, not only asked this question, but, supported by facts, avowed himself as having this view, at least as to the occurrence of miliary tuberculosis. The anatomy of the parts leaves scarcely any doubt that the middle ear is particularly well adapted to serve as the point for the purulent collection, if pus lie in its cellular spaces and undergo calcareous degeneration. *Schwartze*[2] has reported several cases, with the results of the post mortem examination, where tuberculosis of the lungs was developed very rapidly in persons suffering from otorrhœa.

There seems to be a similar condition of things, according to *Virchow's* examinations, in regard to the *cholesteatomata*, or the *molluscous tumors* (J. Müller), or *Mollusca*

[1] Wiener Med Wochenschrift, 1859, s. 195.

[2] Archiv für Ohrenheilkunde, II, 4, s. 280, *et seq.*

Contagiosa (Toynbee), which occur in the petrous bone. *Virchow* advises the substitution of the original name pearl-like tumors (*Perlgeschewülste*) for these terms. These are mother-of-pearl, shining, onion-like, layered tumors, in the posterior section of the temporal bone, which extend through the bone to the external auditory canal—sometimes, also, into the cranial cavity—as a rule, existing with chronic otorrhœa, which usually has a fatal result. Examination proves that they are composed of flakes of epithelium, mingled in various proportions with cholestearine. It appears that here, also, we have to deal with inflammatory products, furnished for the greater part by the superficial surface of the auditory canal, which product is gradually accumulated, dries, and by means of continued peripheral growth, develops itself more and more into a solid body, which acts as an offending substance, and by its pressure wears upon the adjoining parts, causing them to disappear. Since there is only a vacant space posteriorly in the temporal bone, such a dried mass of secretion provides itself with a closed space in that position, until, if its growth be not disturbed, it extends, posteriorly, upon the petrous bone itself, upon the sinus transversus, or upward against the brain, and thus produces a fatal result.

Wherever fatty products are for a long time shut off from any change in material, or metamorphosis, and become stagnant, we see, as is well known, cholestearine formed from them. The pus in the ear furnishes a considerable quantity of fat, as does also the secretion of the numerous sebaceous and ceruminous glands, and the experience of all pathological anatomists, from *Rokitansky* on, as well as that of aural surgeons, prove that in the external and middle ear extensive formations of cholestearine are something very common.

When we considered the diseases of the external auditory canal, we saw that the peripheral layers of a mass of

impacted cerumen often have a shining appearance, and consists of cholestearine crystals, which may be very often found in all cerumen. We often, also, may see cholestearine as glistening points floating in the water, if we syringe an ear affected with otorrhœa.

I have sometimes found the deep parts of the auditory canal filled with flat, whitish bodies, the removal of which required several days with the help of a delicate spatula, or a Daviel's spoon, and which were accretions of epidermis, with the well known large rhomboid plates.

It seems to me probable, after all that has been said upon the subject, that pearl-like tumors in the petrous bone, just as we have seen is the case in "tubercles of the petrous bone," result from the collection of a superficial inflammatory product, and that they are a kind of retention tumor.

It is possible that such a tumor must often be considered as an independent neoplastic formation, from which the inflammation of the ear has secondarily proceeded. It should not be forgotten that such cholesteatomata have several times been observed entirely separate from the outer surface of the body, e. g., in the interior of the skull. However, we may well ask the question whether various kinds of growths have not been frequently confounded by the names cholesteatomata, or pearl-like tumors.

LECTURE XXVI.

PROGNOSIS AND TREATMENT OF SUPPURATION IN THE EAR.

Difficulty of the diagnosis, "caries of the petrous portion of the temporal bone;" the relations of patients with otorrhœa to military service and life insurance companies; thorough cleansing of the ear; manner of using astringents, and their selection; consideration of the general condition; local blood letting; incision behind the ear and in the auditory canal; secondary affections of the auditory canal; trephining the mastoid process; its indications and history; removal of sequestra.

GENTLEMEN: As we have just seen, the prognosis, and, I may add, the therapeutics, in suppuration of the ear, do not depend very much on the transition of the inflammation of the soft parts upon the bones, since experience shows us that nearly all the consequences of otorrhœa that have been mentioned, occur just as well with, as without caries of the petrous portion of the temporal bone. In view, however, of the great importance ascribed by practitioners, in general, to caries of the petrous bone, although very little is attached to a pure otorrhœa, we may spend a little time in discussing the difficulty in diagnosticating the former affection.

Caries.—Apart from the cases where the parts affected by caries are readily seen, on an examination of the ear, and these are rare, it is not an easy matter to decide whether

the inflammatory process has led to softening of the surface of the bone. We should be careful, especially, not to fall into the error of considering every case of otorrhœa where there is a bad odor, as connected with caries, as is very frequently done.

The longer a puriform secretion remains in the ear, and the more material it possesses for the formation of the fat acids, the more unpleasant will be its odor. We therefore find the most disgusting smell in cases of suppuration in the auditory canal, ears that are not kept clean, as a result of the secretion of sebaceous material and ear wax. It is perceived in cases where only the soft parts are affected, and when, as we may assure ourselves by ocular inspection, the bone is not at all involved.

The most common, but, in unpracticed hands, the most dangerous, means of deciding as to the existence of caries in the deeper parts of the ear, is the use of a probe. The use of such an instrument should be avoided if the eye be not made to guide the hand, that is, if the parts to be touched cannot be well illuminated. If the parts are so situated that we can see them, an inspection will teach us more than any amount of probing, which frequently causes hemorrhage, and easily excites pain. We remember how thin the labyrinth wall is at the point which lies opposite the membrana tympani. If we add to this, that it is morbidly softened and tender, we can conceive that only a slight amount of pressure may cause an opening of the cochlea or vestibule. This would be dangerous to the life of the patient, since a way would be thus opened for the passage of pus to the meatus auditorious internus and the cavity of the cerebrum.

But, if by bending the probe we bring it in contact with parts beyond the eye, there is danger of making a false passage, anteriorly into the carotid canal, upward into the cranial cavity, or downward to the jugular vein,

and without any satisfaction of the professional desire for knowledge.

As a rule, then, the use of the probe is of no service in the diagnosis of caries of the ear, while great harm may be done with it. Of course the matter is quite different in abnormal conditions of the outer ear, where we frequently can not dispense with the probe, in order to ascertain the boundaries of polypi or sequestra, whether they have a free or fixed position, and so on.

The one certain evidence of caries in the ear, that is not ocular, is the presence of bony particles in the pus. The appearance of elastic fibers in the discharges (*Moos*), is an untrustworthy proof, since they occur in profusion in the cuticular layer of the auditory canal, and the membrana tympani, as well as in the envelope and tendon of the tensor tympani muscle. Frequent mingling of blood with the pus, when no polypus exists, and no injury has occurred to the parts, from a probe for example, is a suspicious circumstance. Certain pus secreting surfaces, especially a granulating membrana tympani will bleed, however, even after they have been simply syringed with warm water.

I have often noticed that a solution of lead that has been dropped into the ear, was black colored at the same time that a suppurative process in the ear assumed an unpleasant aspect, and that on the other hand, this discoloration did not occur when the morbid process appeared to be becoming better. It is possible that we have, in a solution of lead, a sort of a reagent for caries. We may conceive of a union of sulphur or phosphorus with the lead, for which the material is furnished by the softening and disintegration of the surface of the affected bone.

When mucous flocculi are chiefly evacuated, in syringing, which float about in the water without dissolving in it, we can scarcely imagine that any extensive ulceration exists.

In other respects the external properties of the secretion scarcely ever furnish any positive conclusions.

Besides the general probabilities depending upon the course and duration of the disease, and the general health of the patient, the kind of pain has a certain importance. It is often exceedingly severe in caries of the petrous bone. It is described as a pain that bores into the deep part of the ear. It may continue for days and weeks without interruption, and appear suddenly at night without any evident cause. If a pain of this kind occurs, which is very frequently accompanied by only a very slight discharge, and frequently returns without any external cause whatever, and without any evidence of recent inflammation of the soft parts, if it cannot be referred to a displacement of the opening of the membrana tympani, or any other cause for retention of the secretion, we may always think of caries of the bone as one of the possibilities, and yet this symptom is no certain diagnostic evidence of its existence.

I have made post mortem examinations in cases of caries of the ear, that existed for years without any pain whatever, and where it was only at the close of the scene that it occurred, and then with dreadful and increasing severity. It is a suspicious symptom, when the instillation of even weak astringents always causes pain in the ear.

Prognosis. From what has been said, you see how careful and reticent we must be, in regard to the prognosis of chronic otorrhœa, since we can never say with certainty, how far deeply seated morbid changes may have gone on, which from the nature of things lie beyond our therapeutic aid. *Wilde* very well says: "*So long as a discharge from the ear exists, we are never able to say, how, when or where it may end, nor to what it may lead.*"

In opposition to such an earnest appreciation of the affection, you will find, that the most of the profession,

even more than the laity, regard an otorrhœa as quite a trifling affection, and as scarcely worth the trouble of any continued treatment. A suppurating wound in the outer surface of the skull, after an injury, for example, is certainly considered worthy of attention by every surgeon; the same condition in the interior of the head, in a space so narrow and so irregularly formed that the pus very readily becomes fetid, in a situation that is adjacent to so many important parts, is very often thought worthy of only a few consolatory words, or a contemptuous shrug of the shoulders.

A person suffering from a chronic discharge from the ear, should not be subject to military duty, because he is exposed in the performance of this service to many injurious influences which may cause his life to be in danger.

Several English life insurance companies decline to insure the lives of persons affected with otorrœa. This refusal must be considered as perfectly justifiable, and as one that might well be imitated by our German companies. Every case of suppuration in the ear may under certain circumstances lead to an affection that is dangerous to life, and we do not always possess the power of preventing such consequences. From the stand-point of life insurance companies it should also be considered, that even large abscesses in the brain and other common consequences of purulent inflammations of the ear, may be developed in a latent manner, so that their existence is not suspected until just before death occurs.

Generally speaking, we may say, that cases where there is a large loss of substance of the membrana tympani are the least in danger of deeply seated affections, if the exit be not interfered with by polypoid growths or by an accumulation of the secretion. The latter may occur by an adhesion of the posterior or upper border of the perforation, in a manner that is with difficulty recognized during

during life. It is a retention of the pus, that most frequently leads to dangerous consequences. There are, indeed, cases recorded, where patients suffering from otorrhœa, have finally recovered after the continued existence of typhoid symptoms, with chills, metastatic abscesses, but these cases are certainly exceptions.

Prescott Hewitt has recorded one of the most interesting of these cases.[1] In connection with very severe typhoid fever and chills, there was decided pain in the course of the jugular vein, and abscesses formed in the sterno-clavicular and hip articulation. Inflammation of the knee joint, and symptoms of pneumonia were also added. In spite of all this the patient gradually recovered under the use of wine and morphine.

Fortunately, such consequences as we have been considering, only occur as a rule in cases that have existed for some time. They may, therefore, usually be prevented by an appropriate and early treatment of the original affection. Even in a very old case of otorrhœa, we may often do a great deal of good in opposing the extension of the inflammatory process. Very frequently, as our previous observations have shown, the hearing is greatly improved by treatment. I may finally warn you not to immediately make an unfavorable prognosis, when a slight chill occurs in the course of an otorrhœa.

Treatment.—The treatment of an otorrhœa consists above all things, in the thorough removal of the secretion. We may use simple luke-warm water, for the purpose of injecting the ear. When the cavity of the tympanum is exposed, we may add a little common salt to the water. The disadvantage of using chamomile tea (much used in Germany, but not in the United States), as well as other

[1] London Lancet, Feb. 1, 1861.

decoctions, is that they leave organized material in the ear, which favors the disintegration of the secretion.

The necessary injections with luke-warm water should be made very carefully, since a heavy stream from a large syringe may easily do great damage, in the sensitive and relaxed condition of the parts. Sometimes, even when the greatest precautions are taken, vertigo and fainting result from these injections, even in cases where the membrana tympani is not perforated, and the fluid does not enter the cavity of the tympanum. In some cases, the ear is more easily cleansed by the use of a small camel's-hair brush, especially when the secretion is small, or there is a tendency to the formation of furuncles in the auditory canal.

In all cases where pus is formed in the cavity of the tympanum, and this occurs in by far the greater number of discharges from the ear, this sort of cleansing of the ear will not be sufficient, especially when the opening in the membrana tympani is small. Such a small opening prevents both the passage of the pus outward, as well as the entrance of the cleansing stream of water.

Where we are dealing with a purulent catarrh of the middle ear, the pus should be forced from within outward. This may be sometimes done in a very simple manner, by causing the *Valsalvian* experiment to be practiced by the patient before the syringing is undertaken. It is better, however, to employ Politzer's method or the air bath by means of the cathether, which may be followed by the injection of salt water through the Eustachian tube. If there is a perforation on both sides, in cases where the use of the cathether is not practicable, especially in the case of young children, forcible injection of a weak solution of common salt into the nose, according to *Gruber's* recommendation may be of use.

By such means, all the secretion that does not lie in the

most posterior portion of the cavity of the tympanum, and in the cells of the mastoid process, is thoroughly driven into the auditory canal, and at the same time the natural passage for the running off of the secretion, the Eustachian tube is kept open.

The ear should be thoroughly cleansed once or twice a day, or even oftener, according to the amount of the suppuration. Not unfrequently we may syringe the ear and cleanse it with a camel's-hair brush in alternation. If the secretion be very thick, or if we desire to remove a large amount that has collected, it will be well to fill the ear with warm water for some time before the syringing is undertaken, in order that the secretion may be better dissolved and more easily removed. If the patient lies on his back at the same time, a portion of the water will pass into the mastoid cells, in which great quantities of thickened secretion are often found, and we may thus succeed in cleansing the whole middle ear as thoroughly as is possible.

Astringents.—In not a few cases, especially in recent ones, the suppuration decreases under the simple cleansing of the ear; it may even cease entirely and the perforated drum be healed. It is more frequently necessary, however, to act upon the tissue, which furnishes the abnormal secretion. This is generally accomplished by the means of astringents. A mere instillation of astringent ear drops into the auditory canal is only sufficient in an affection of the external ear, or when the perforation of the membrana tympani is a very large one. We must cause the astringent to act more thoroughly upon the mucous membrane in another way.

We formerly accomplished this latter by the injection of astringent solutions into the ear, through the catheter. *Politzer* has recently shown us another method of bringing

medicated fluids in contact with the mucous membrane of the middle ear, when the drum is perforated. The auditory canal of the patient, who inclines his head to the opposite side, is filled with the astringent solution, and then in one of the three methods, Valsalva's, Politzer's, or by the catheter, the air in the Eustachian tube is compressed. As soon as the air passes through the perforation of the membrana tympani, it appears in the auditory canal, which has been previously filled with fluid in the form of bubbles, and at the same instant, the astringent must enter the cavity of the tympanum. In this simple manner the fluid comes in extensive contact with the morbid mucous membrane. This method has the double advantage, that it may not only be employed by a physician, who is not very certain in his use of the catheter, but also by the patient himself or by his friends, at each use of the ear drops. In appropriate cases, weak astringent solutions may be also employed by Gruber's method.

Choice of astringents.—Acetate of lead and liquor ferri sesquichlorati, take a first rank as to the power of diminishing secretion. Unfortunately, however, these agents are decomposed, partly by the air, partly by the purulent secretion, and thus form a precipitate in the ear. These deposits, which are usually white, seldom black, when resulting from lead, or of dark brown color from the iron, prevent a proper estimation of the condition by means of the discoloration which they cause. They may also cause irritation to the inflamed parts, and a retention of the secretion. Finally, they may unite with the relaxed and inflamed mucous membrane itself, and cause permanent deposits, such as we sometimes see on the cornea, from the inappropriate use of eye drops.

Such deposits on the membrana tympani, and in the

cavity of the tympanum, may impair the functions of the ear by diminishing the elasticity of the vibrating parts. Whenever, then, there are any excoriations of the drum, or it is perforated, it will be well to entirely avoid the use of these two agents, especially when the medical attendant can not himself cleanse the ear every day, and remove all metallic deposits that may occur.

Recently I have begun to employ solutions of lead again. If we add an equal quantity of acetic acid to the acetate of lead solution, the white deposit from the carbonate of lead does not form.

When the proliferation of tissue is limited in extent, we may, however, use the solutions of lead as well as the liquor ferri, by pencilling it on the parts with a camel's-hair brush.

Sulphate of zinc is a very useful astringent, when employed in the proportions of from one to six grains to the ounce of water. The acetate of zinc is very frequently too irritating in its effect, even in very weak solutions. *Toynbee* recommends the chloride of zinc, and *Rau* the sulphate of copper, especially when caries of the bone exists. I would advise the further trial of *plumbum nitricum*, which has at times done me very good service.

Solutions of common alum are not always certain in their effect. They also have the disadvantage that they often cause furuncles to occur in the canal. The acetate of alum is to be preferred. It is well to use it in a fresh state, made from acetate of lead and alum.

Politzer has recently advised the use of powdered alum. I have observed very speedy diminution of the secretion, and even the shrinkage of small granulations after its employment. In order that the powder may get in the ear as deeply as possible, and not be checked at the cartilaginous portion of the canal by the hairs, an ear speculum is

first introduced, the head of the patient inclined to the opposite side, and the powder gradually introduced, in small quantities, from an ear spoon. The irritation produced is very slight, and the powder may be left a day or more in the ear, when the ear should be thoroughly cleansed, because the alum, with the secretion, will form fine lumps. I have never observed that furuncles occurred after such a use of alum. I have used crude, pure and burnt alum in this way, but without any great difference in the effect.

Hinton, of London, advises absorbent powders simply, and for this purpose employs calcined magnesia, with the addition of a little morphine. (I have used the latter agent, without the morphine, however, and with good effect. St. J. R.)

A weak solution of nitrate of silver is far inferior to the astringents that have just been named, apart from the fact that it discolors the parts so much as to render accurate observations of the case somewhat difficult. Stronger solutions, however, of from twenty to eighty grains to the ounce, do very excellent service, especially in very obstinate cases of otorrhœa. The solution should be neutralized by the subsequent injection of salt and water. The irritation following is generally either none at all, or very slight. Sometimes, however, the pain is considerable, but I have seen no other disadvantage following the use of such solutions. It is a means of using an astringent that may be generally recommended. I have to thank my esteemed friend *H. Schwartze*, of Halle, for its suggestion. Mineral astringents are usually to be preferred to the vegetable. *Tannin* alone, of the latter, occasionally does good service.

Since all astringents lose some of their efficacy after long-continued use, we can not usually employ the same ear drops longer than from four to six weeks. A

great number of such agents, from which to choose, is therefore necessary, where the case is one of long duration. Before we proceed to the use of a new agent, it is well to let a few days pass without the use of any, because experience seems to show that the new agent will then produce more effect.

It is not well to use the astringent for syringing the ear. The ear is simply syringed with luke-warm water. If there be a very great odor to the pus, we may at the most add some tar water, chlorine water, liquor kali hypermang anici, or a solution of chlorinated soda, to the fluid to be injected. The astringent is then dropped in, the head being turned to the opposite side, and allowed to remain in the ear from five to ten minutes, during which time, if a perforation of the membrana tympani exists, the air should be forced into the ear several times.

Constitutional treatment.—The general condition of the patient should be carefully considered in cases of suppuration in the ear. There is no form of aural disease where general treatment, such as a system of baths, change of air, and especially a continued residence in a warm climate, do so much to assist the local treatment. The latter, however, is the chief thing, and with people who are in other respects healthy, will be sufficient of itself. Where decided and far advanced phthisis pulmonalis exists, the most careful local treatment is at times without influence upon the amount of secretion. In such cases a very rapid deliquescence of the membrana tympani is sometimes observed, against which our efforts are utterly ineffectual. It is a very striking fact that in patients with tuberculosis, very great destruction of the membrana tympani, without any pain, sometimes occurs in a very short space of time. In such cases nothing can be done except to induce the patient to go to a better climate.

A depressing system of treatment, that is, a diminution of the ingesta, with increase of the excretion (inunction and sweating cures), very rapidly diminish the suppuration in the ear, as you would naturally suppose, but such a method of treatment will hardly do any permanent good to the patient, and may do harm, by diminishing his strength.

Local blood-letting.—If sub-acute attacks occur, local blood-letting, together with light diet and purgatives, will be the best remedies. In the existence of deep-seated disturbances of circulation in the ear, the artificial leech may be applied on the mastoid process. The benefit from such a local blood letting is frequently very marked. I recall a case where, in the course of an otorrhœa that had existed for years, a paralysis of the facial nerve suddenly occurred, which disappeared immediately after *Heurteloupe's* artificial leech had been applied to the mastoid process.

When, in the course of an otitis, with or without otorrhœa, the mastoid process begins to be painful, and tender on pressure, and the swelling and redness of its covering indicate an inflammation of the bone, lying under, a free incision of the soft parts down to the periosteum, is often of great use. *Wilde* recommends this procedure as one by which a process dangerous to life may be restrained, and I have had opportunities to test the use of such incisions.

(In the New York Medical Press, vol. II, p. 833, occur some clinical remarks of Prof. A. C. Post on the subject of post-aural inflammation, which show a full appreciation of the affection.

"Patient, aged 30, came to the Professor's clinic on account of pain in his ear and about it.

"We have here, gentlemen, a swelling behind the ear, involving the deeper tissues, called a post-aural inflamma-

tion. It is very dangerous in its character if not properly attended to, having the general character of a paronychia. *If not relieved by incisions* it will involve the bone, cause necrosis, extend to the encephalon, and with great suffering cause the death of the patient. I once attended a young girl approaching maturity, with præ-aural inflammation, an affection of the same character with the present case, in front of the meatus auditorius externus. It went on to the destruction of the anterior margin of the external meatus, but the patient recovered with a loss of bone. A sister of this same patient was attacked with the same affection, and died from its extending to the encephalon. She was not under my care, but the case came to my knowledge.

"Incisions should be made fairly down to the bottom of the parts, so as to allow free exit to the matter, and relieve the tension. Such an incision was then made between the course of the occipital and posterior auricular branches of the external carotid. Pus was found next to the bone." St. J. R.)

The incision must be long enough and be made with a powerful hand, in order that the periosteum may be fully divided. The swollen condition of the parts often renders the depth to which the knife may reach, very considerable. The incision should be made parallel with the attachment of the auricle, so that the posterior auricular artery may not be injured. The hæmorrhage may be considerable. If an artery spouts, it may be twisted. Even if there be no evacuation of pus, the discharge of blood will afford great relief, and better the condition very much. If the circumstances require delay, apply poultices. (I can imagine few circumstances admitting of delay, and my experience includes quite a large number of these cases. St. J. R.)

A free incision into the soft parts of the posterior or upper wall of the bony canal is often of great value in

the treatment of an *otitis media.* As we have already seen, the posterior osseous wall of the auditory canal is chiefly formed by the mastoid process, while the hollow spaces of the temporal bone, connected to the cavity of the tympanum and the *antrum mastoideum*, extend into the upper wall. The bony cells of the middle ear thus extend very far externally, even to the cartilaginous meatus. From this cause the integument of the external meatus is often secondarily involved in suppurative processes in the middle ear. An abscess, after perforating the bone, which is sometimes very thin, may collect under it, or the cutis of the canal may be sympathetically affected, or undergo swelling and infiltration proceeding from the periosteum.

I once saw a case where as a result of a very severe inflammation of the ear, a fistulous opening, which secreted a great amount of pus, existed on the upper wall of the meatus, very near the orifice. The pus had made its way through the cells of the temporal bone and avoided the membrana tympani. It would not be so easy for a primary abscess of the auditory canal to open internally, but such a case is possible.

Even in cases where the color or sensitiveness of the auditory canal exhibits no evidence of inflammation, and, when we certainly have no abscess, I have often seen benefit result from a free incision into the soft parts of the canal, apart from the fact that it may be often indicated to allow an exit of the pus that has collected behind. If the swelling be relaxed and not very sensitive, we may remove the secretion by means of a camel's-hair brush (or a small stick or bit of wire, about the extremity of which cotton is twisted. St. J. R.)

Occasionally, in consequence of very frequent or long-continued injections of the ear, a perfectly painless, relaxed condition of the integument of the upper wall of the auditory canal occurs, which causes it to sink downwards.

We should then avoid moist applications for some days, and cleanse the ear by means of the brush or cotton, until the normal condition of the ear returns.

Trephining the mastoid process.—If we have reason to believe that there is a collection of pus in the interior of the temporal bone, and especially of the mastoid process, the treatment usual in abscesses in bone should be adopted. Where the circumstances require delay, we may endeavor to favor suppuration by applying poultices behind the ear. It is a much safer plan, however, in such cases, to perforate the mastoid process, and thus evacuate the pus externally.

We not unfrequently, especially in children, see such an opening behind the ear form spontaneously, or—as we are accustomed to say, through the curative power of nature—and an immediate benefit accrue to the patient from the evacuation of deeply seated pus.

If this operation has been forgotten, or has come into disrepute, it is because of its abuse in the preceding century, as well as in the peculiar and exceptional position of the literature of otology until a short time ago.

Principles, which in other departments of medicine are accepted as rational, methods of treatment, which surgery views as absolutely necessary, under exactly the same circumstances, were not applied to the ear and its diseases.

In the greater number of cases it would be allowable to wait and see if the incision that has been recommended to be made behind the ear, or in the auditory canal, be not sufficient of itself to give a more favorable turn to the condition, and we may then, in case of necessity, trephine the mastoid process a day or two subsequently. An incision is first made through the integument down to the bone. Where the bone is soft and brittle, a strong pressure from the knife, or a probe, will be sufficient to perforate it and

to enter the mastoid cells. Where the bone is thicker and stronger, a small gouge, or *Lucae's* gouge forceps may be used. It is only when the outer bony lamella is very thick and hard, or when the whole mastoid process is sclerosed—the hollow spaces being changed to a dense bony mass, as often occurs after the long-continued, deep-seated inflammation—that it will be necessary to use a trephine.

Generally the object desired is to open the larger space that always exists close behind and above the cavity of the tympanum, called the *antrum mastoideum*, or horizontal portion of the mastoid process. The instrument is placed on the bone on a level with the upper border of the outer meatus, from one-fourth to one-half an inch behind the attachment of the auricle, and is worked slightly forward in a horizontal direction. By thus proceeding the dura mater and transverse sinus will be avoided. The depth to which we must go is sometimes very considerable.

Of course great care is to be taken, and frequent pauses should be made before the bone is perforated, in order that we may not, as it were, fall into the mastoid cells with the instruments. When the dense outer bony plate is perforated, any further work on the bony septa may be done by any strong forceps.

After having in this way made a place of exit for the fluid pus collected in the interior of the ear, the thickened secretion and that which is constantly forming should be removed by injections. The wound should be filled up with charpie in order to prevent it from closing. By such a counter opening a thorough cleansing of the suppurating surface is rendered possible. We therefore find that in all the cases where recovery has occurred, that the otorrhœa which had existed for years soon ceased, and that the general condition of the ear was permanently improved.

This operative procedure is to be reckoned among those which may be indicated in order to save life. As every

physician may feel himself compelled, under certain circumstances, to open the larynx, or to operate for strangulated hernia, so there are times when the perforation of the mastoid process remains the only remedy which may possibly save life.

If we compare the slight amount of danger from the procedure, with the certainty that such a counter opening will aid in finally checking a purulent discharge from the ear, and with the fact that even very insignificant cases of otorrhœa may finally cause death, it is possible that perforation of the mastoid process may be yet advised as a means of treating an obstinate otorrhœa, and for the removal of any collected secretion, even where there are as yet no threatening symptoms. The cause of death, in the case above indicated, is usually a collection of inspissated secretion in the antrum mastoideum.

The longer a suppurative process has existed in the deeper parts of the ear, the more rarely a syringe has been used, and the smaller the external opening (which is usually in the membrana tympani), the more probable will it be that a collection of dried and hardened pus has formed in the cavity of the tympanum, and in the large cells behind it. It should also be observed how frequently tuberculosis of the lungs or other organs has been developed where these collections have occurred. (See page 444.) It is almost impossible to remove these collections in any other way than by perforation of the mastoid process, and the subsequent injection of the parts. We should remember, finally, that the operation, according to the experience yet had with it, is by no means a very serious procedure.

Historical.—*Riolanus* in 1649, and *Rollfink* in 1656, first proposed to perforate the mastoid process. It was only advised by both of these authors, however, in cases of deafness and tinnitus aurium, dependent upon occlusion of the Eustachian tube. *Valsalva* in 1704, was the first surgeon who injected a fistula already existing behind

the ear and thus cured a very obstinate otorrhœa. *Petit* and *Hurmann* first advised the perforation of the mastoid process in the existence of caries and of a collection of pus in the part. *J. L. Petit* is said to have first performed the operation by means of a gouge and hammer.

The operation is best known through a military surgeon, *Jasser*, who in 1776, half accidentally perforated a mastoid process with a probe, after he had cut through the integument. He was enabled by means of injections through this opening to free a soldier from the most fearful pain, a febrile condition that had existed for weeks, and from an otorrhœa of years standing. This surgeon repeated the operation with a trochar under circumstances, and described his method. It has hence received the name of *Jasser's* operation. After this, the operation was performed by various surgeons, but almost always as a remedy for deafness without otorrhœa. The hearing of some patients was restored, and to none of them did any particular harm occur, so that the operation was generally considered as a useful one, and as unattended with danger, until a Danish surgeon, *Berger*, who suffered with every disturbing tinnitus and deafness, prescribed the operation for himself, and soon died of meningitis after its performance. Since that time (about the close of the last century), this operation which was at first enthusiastically undertaken, and performed without any regard to the cases for which it was adapted, has fallen into great discredit.

Literature.— *Tröltsch* Virchow's Archiv Bd., xxii, 1861, s. 295; *Pagenstecher* Archiv für Klin. Chirurgie Bd., iv, s. 325, 529, 533; *Turnbull*, Medical and Surgical Reporter, Philadelphia, 1862, Feb. 15; *Schwartze* Prakt Beiträge zür Ohrenheilkunde, s. 37; *Mayer* Archiv für Ohrenheilkunde, I, s. 226, II, s. 228.

Professor *Von Bruns* informs me that in two cases he has enlarged a small fistulous opening of the mastoid process, with a small trephine.

Removal of necrosed bone.—The perforation of the mastoid process often only breaks the way for the removal of a sequestrum which lies deeply situated in it. The artificial or natural removal of a necrosed piece of bone

from the auditory canal is not unfrequently necessary, in order to terminate a suppurative process in the ear.

In this way, the entire osseous labyrinth, that is, that part of the petrous portion of the temporal bone which includes the cochlea, vestibule, and semi-circular canals, is quite often thrown off. There are a number of cases recorded where the patient not only was saved from death by the removal of the sequestrum, but also where he recovered from various affections, e. g., from hemiplegia.[1]

(In the first American edition of this work I appended a case of the removal of the internal ear during life, reported by Dr. C. R. Agnew. Since it excited very considerable interest, and was copied into numerous journals from my translation, I have again added it to the author's account of these cases. The sad termination of the case from an exostosis of the auditory canal of the opposite ear, which caused a retention of the pus, and secondary meningitis, will be found recorded on page 131 of this work.

W. C.,[2] aged 38, had suffered from otorrhœa from the right ear for the greater part of thirty-two years. The origin of the disease was obscure. Considerable sense of hearing remained till three years before the case came under my observation, at which time an exacerbation of the aural inflammation, accompanied by prolonged and excessive pain deep in the ear, and through the neighboring parts of the head, terminated in total loss of hearing in the affected organ, and paralysis of the corresponding portio dura of the seventh pair.

Several times during the progress of the disease granulations sprouting from the depths of the external ear, outcropped at the meatus, and were removed by torsion.

[1] *Toynbee*, A. F. O., I, s. 112; Tröltsch, Virchow's Archiv, B. XVII, s. 47; Gruber, Allgemeine W. Zeitung, 1864, Nos. 41-45.

[2] American Medical Times, Vol. VI, p. 183.

The patient came under my observation for the first time, on the 16th April, 1862, presenting evidences of great suffering and debility.

He had suffered greatly for months from growing pain in the ear, insomnia, loss of appetite and dizziness. An examination of the external ear was effected with great difficulty, on account of its excessive tenderness. The concha, swollen and inflamed, was elevated by a dense inflammatory tumefaction, circumscribing the external meatus, extending backward over the mastoid process, and forward along the zygoma. Projecting from the meatus was a large pear-shaped polypus of a dense fibrous character, bathed by a constant flow of stinking pus. Desiring to get to the bottom of the case, I placed the patient under chloroform, and removed the polypoid mass by means of a wire snare. In attempting to push the snare to the bottom of the meatus, I encountered a solid obstacle in the region of the middle ear, which subsequently proved to be the sequestrum, represented by the accompanying wood-cut. The caliber of the external meatus had been greatly reduced by boggy swelling of its soft parts, so that I was compelled to make as free an incision as possible to enable me to reach the sequestrum with a pair of small dressing forceps. Having got the body in the grasp of the forceps, a slight rocking motion, with traction, enabled me to extract it.

Fig. 36.

Fig. 37.

It will be observed that the sequestrum includes the wreck of the labyrinth. The cochlea is shown laid open

by caries, and two of the semi-circular canals are seen in part. The loss of hearing and paralysis of the seventh pair were explained. Two views in facsimile are given of the sequestrum, in the wood-cut, and an attempt has been made by the artist to represent the eroded appearances.

The remains of the anterior semi-circular canal are indicated by the letter C, the cochlea B, opened by caries, shows the lamina spiralis. The vestibule, E, A, D, is bereft of its furniture, and almost obliterated. After the operation, the patient rapidly regained his health, and by the 3d of January, 1863, the external meatus had become closed by cicatrization. The paralysis still remains. St. J. R.)

Allow me a few words, now, as to the prejudice which exists among the laity, and which proceeds from the profession, against stopping an otorrhœa, out of regard to the general health. I have always found, that with a gradual diminution of the aural discharge, the general condition is improved; and that very many persons lose their lives because the disease is allowed to go on.

When, for the first time, I saw an otorrhœa which had existed for years, disappear after the removal of a polypus, so to speak, in the twinkling of an eye, I took the precaution to order laxatives for a few days, or, in other cases, the establishment of an issue on the arm. One patient, disgusted with the uncleanliness, allowed the sore to heal; another did not carry out my directions; neither case was followed by evil results. Since then I allow over-anxious persons to drink "bitter wasser" for some days, in order to quiet their fears, because I have learned that such a sudden cessation of the discharge is *not* productive of evil results.

When there is no polypus, foreign body, sequestrum, or the like, and the otorrhœa, with our best efforts, will not cease, we may well regard any opinion of the surgeon

against the sudden stoppage of the discharge, as very like that of the fox in the fable, as to the taste of the grapes which were beyond his reach.

We can only treat a discharge from the ear successfully when we know the cause of the malady. Since this is often unknown, the treatment often fails to do the patient any good, and then the idea occurs to both the patient and the physician, that on the whole, it is better to leave the whole thing to good dame Nature. If a sudden lessening of an otorrhœa occurs at the same time with some general malady, it is immediately concluded that the sudden stoppage of the discharge is the cause of the disease. Cause and effect are here confounded; another reason must be sought for. The discharge ceased, because from some kind of an injurious influence, possibly from the use of an inappropriate, or too strong ear-wash, an acute inflammation of the ear has occurred. There is less purulent discharge, because it has suddenly made its way inward, or from the fact that in some mechanical way it has been shut up in the depth of the ear. This last cause for a diminution of discharge produces the worse condition, and the affection of the brain.

But, for the justification of the general practitioner, one more remark should be made. This erroneous belief that local remedies may easily do harm in otorrhœa, that they may "suppress it," and that we should therefore attempt to subjugate the affection by internal treatment, has been for the most part encouraged by aural surgeons themselves, especially by those French authors who have in other respects contributed very much to our knowledge, *DuVerney* in 1683, and *Itard* in 1838.

LECTURE XXVII.

AURAL POLYPI.

Their origin and structure; treatment.

FOREIGN BODIES IN THE EAR.

Most of the methods of extraction more dangerous than the foreign bodies; an operation proposed for doubtful cases; foreign bodies in the ear often the cause of peculiar reflex symptoms; several cases.

GENTLEMEN: Among the forms of disease that not unfrequently keep up an obstinate otorrhœa, is polypus of the ear. Such a growth is usually developed in consequence of a long-continued suppurative process. I saw aural polypi develop in two cases, however, where there had been no purulent inflammation previous to their origin.

Aural polypi may be described as vascular tumors, usually of a bright red color, and roundish contour. They are sometimes very soft, and bleed on any contact with them. Again they are tense, and have a shining surface. Their structure is often grape-shaped, or lobulated. Sometimes they have a broad base, while at others they have a small pedicle. They vary exceedingly in density and size. In some cases they fill up the whole caliber of the auditory canal, and even project out of the meatus like a fungous growth. Again they can only be detected at the bottom of the ear by a thorough and careful examination

when they are found imbedded in pus and secretion, and scarcely as large as a hemp seed. When lying very deeply an aural polypus is always red and soft. It sometimes resembles a strawberry, since its roundish surface is completely covered by little granular elevations. When a growth extends to the external meatus, it is covered by a rigid, non-secreting integument, so that at the first glance it may be mistaken for a part of the auricle, or for a button-shaped outgrowth.

Aural polypi may originate in all the different parts and divisions of the ear. According to my experience, they most unfrequently arise from the external auditory canal, when they take their origin from the immediate vicinity of the membrana tympani. We may then see quite a number of them with independent roots around the membrane. *Wilde* and *Toynbee* have found on the contrary that they most frequently arise from the auditory canal. The latter named author has most frequently seen them on the posterior wall of the canal. (*Clarke*[1] of Boston, also states the most frequent point of origin of these growths to be the auditory canal; of thirteen cases reported by him, eleven arose from some part of the meatus. My experience indicates the cavity of the tympanum as the common point of origin of aural polypi. St. J. R.)

If they arise from the surface of the membrana tympani, it is generally from the posterior and upper portion near its margin. I once found, on the dead body, in connection with a polypus of the external auditory canal, and one of the Eustachian tube, a third, which in accordance with its position and microscopic structure proved to be a polypose, degenerated membrana tympani. I have also, on the living subject, met with excrescences, the form and extraordinary sensitiveness of which led me to regard them as proliferations of the membrana tympani.

[1] Observations on the Nature and Treatment of Polypus of the Ear. Boston, 1867.

Aural polypi most commonly arise from the mucous membrane of the cavity of the tympanum, and from the upper portion of the Eustachian tube. Very often, growths, which half fill the auditory canal, have their origin just behind the membrana tympani, partly in the mucous fold of the membrane itself. If polypi extend out of the cavity of the tympanum, through a hole in the membrana tympani, they make almost the same impression as if their origin was in the membrana tympani itself, and mistakes as to their point of origin may readily occur.

I can show you a preparation where a growth, which during life, was considered to be a polypus of the auditory canal, on more exact examination on the dead body, was found to proceed from the hollow space belonging to the middle ear, which lies above the osseous part of the auditory passage. It then seemed as if it sprang from the integument of the upper part of the meatus.

Developed granulations of connective tissue are often comprehended in the term aural polypi, and practically we can say nothing against such a view.

Of the aural polypi which I have examined, only a few had hollow spaces on section; among these was the degenerated membrana tympani above described. The cavities were filled with detritus, fat corpuscles, and granular bodies. The others were solid, principally consisting of connective tissue, with a few fibrous filaments. They do not always possess ciliated epithelium, as has been asserted, but it may be sometimes distinguished in the various lamellæ, in the deeper structure, when on the external surface none is detected. In large polypi, the part at the meatus is rigid, having a smooth whitish surface, and is covered by smooth epithelium, while on the under part, which is soft and red, there is cylindrical epithelium on its granular or lobular surface, and some ciliated structure.

The lamellated structure is best seen by examining the growth under water.

As has been said, these growths generally occur as a result of a long-continued purulent process. An otorrhœa may be maintained for a long time by a polypus, since it will secrete pus very freely, and keep up the irritation in the morbid tissue beneath, while, if it were removed, the chronic inflammation would probably subside, and the part be covered by a new membrane.

An otorrhœa, which we cannot check by local treatment and cleanliness, will be often found connected with excrescences, which, be they never so small, are the only explanations of the continuation of a chronic inflammation of this kind. If you remove them, the inflammation immediately closes as if it were cut off. Blood is often mingled with the pus in varied proportion in such cases.

Such growths may grow very rapidly, and to a great size. I saw a case in a young man whom I treated on account of an exacerbation of otitis interna with perforation. I allowed him to go home after the subsidence of the acute symptoms. Six weeks after a polypus formed, reaching out to the meatus, and of which there was not the slightest trace when I last saw him.

Treatment.—We may remove very small growths by means of repeated applications of nitrate of silver. We may cause larger ones to shrink away by pencilling them with acetic acid, with tincture of opium, with the infus. or tr. cantharides, with a strong solution of sulphate of zinc (40 to 60 grains to the ounce of water), or with creasote. Such procedures are slow, unsafe, and, when with creasote, very painful. In certain cases, powdered alum strewn upon the part, does very good service. *Gruber* advises the use of equal parts of alum and sulphate of zinc upon granulations.

When it is possible, I would advise the resort to an operation, and, I do not know any better instrument for removing them than Wilde's polypus noose or snare, which I now present to you.

This consists substantially of a steel shaft, bent at an angle at the middle. The lower end of the shaft is round, while the upper is of a quadrilateral shape, in order that a cross-piece may be moved upon it. A fine wire is made to run from this cross-piece, the length of the instrument, through rings at the side. The handle has a half ring for the thumb, by means of which the whole apparatus is held, while the cross-piece is drawn back with the index and ring-finger.

The handle and cross-piece are made of German silver. Wilde recommends a steel wire, but I use one of silver, because it does not rust so easily. When we have ascertained, by means of a sound, the position and depth of the polypus, we make a noose of the wire, just large enough to encircle the base of it. We then pass the instrument in, and the noose about the tumor, and by means of the cross-piece draw the wire back, and thus cut through the polypus. The hæmorrhage consequent on the excision is generally considerable. After the ear is syringed out, we examine it anew, and often find another polypus, which we should immediately attempt to remove.

When these polypus growths extend very far out of the ear, the integument of the auditory canal is swollen and excoriated, so that in consequence of the increased narrowness and sensitiveness of the part we are not able to pass the noose to the bottom, and are obliged to remove the excrescences piece by piece. Since considerable hæmorrhage arises after thus cutting off a piece, the subsequent examination and reapplication of the instrument is impossible, and we are obliged to subject the patient to several sittings in order to remove the whole of the morbid growth.

We learn the value of Wilde's instrument in removing very small granulations which may rest on the membrana tympani itself, and which, on account of their smallness and deep situation, we can scarcely reach with any other

Fig. 38.

Wilde's polypus snare.

instrument. In other methods of removal we run the danger of causing severe pain to the patient, and of injuring the membrana tympani, but with this noose introduced through the speculum, and illuminated by the con-

cave mirror, it can be removed close to the base in a moment of time.

As I have said, I prefer this method of removal with Wilde's noose to any other, and in only one instance, where a long-existing, dense, and thick polypus reached out to the meatus auditorious externus, did it fail me. No wire could cut through such a hard body as this was. I could not bring scissors or knife to my assistance, and it seemed to me too formidable an operation to undertake to remove it with the polypus forceps or pincers. We can never tell beforehand where polypi of the ear have their origin, and in using the forceps we may remove a portion of the wall of the cavity of the tympanum, or of the membrana tympani.

It may be that the use of this last-named instrument has taught many authors to consider the removal of aural polypi dangerous, and caused them to warn the profession from attempting the operation, for the pincette or forceps are almost generally used, and in many cases whatever comes in their grasp, be it polypus or not, is dragged out.

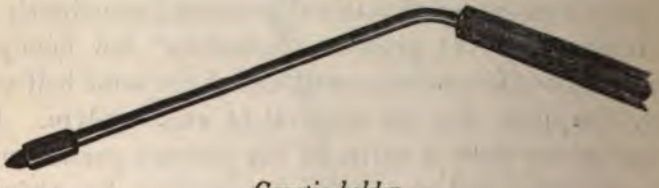
As many polypi as I have removed, I have never seen other than favorable results. In one case there was a relief from a sensation of cerebral pressure immediately after the removal of the growth. *Schwartze*[1] saw hemiplegia with ptosis and imperfect anæsthesia of the same half of the body, disappear after the removal of aural polypi. Even in cases where there is caries of the petrous portion of the temporal bone, and the polypi are nothing less than proliferating fleshy growths, I have no hesitation in removing them in one way or the other. It is also true that such excrescences in many cases disappear of themselves, after a necrosed bone is removed from the ear, but that before the bone is healed, they spring up very rapidly after being removed. It is true, however, that we cannot always pro-

[1] Archiv für Ohrenheilkunde, I, s. 147.

tect the patient from a fatal result by such a removal, especially if we operate too late. If the polypus be removed to a certain depth with a wire noose, the roots may be removed by cauterization with the nitrate of silver, after we have cleared the auditory canal of all secretion, and dried it by means of cotton introduced with a forceps, or the remainder may be brought to a gradual shrinking process by the use of strong astringents.

We should never omit such an after treatment of polypous growths, or there will soon be a new formation in place of the old one. This is the more necessary when a portion remains in the cavity of the tympanum, in the depth of which there can be no thought of an operative expedient, or at least only to a very limited degree. If the different portions of the swollen tissue at last separate themselves through thorough cleanliness, and the use of astringents, we may remove one or the other of the excrescences by means of the noose or caustic. I use a very fine point of nitrate of silver for cauterizing the middle ear by means of the caustic-holder here presented.

Fig. 39.



Caustic-holder.

It would be very wrong to leave the patient to himself immediately on the removal of the polypus. The inflammatory process giving origin to the growth, which is most frequently a purulent catarrh of the middle ear, should be thoroughly treated, and removed in the manner that has been previously described, otherwise our treatment will be

nly palliative, and sooner or later another proliferation f tissue will occur. On the other hand, it is surprising ow much even old and severe cases may be improved by uch a consecutive treatment, not only as to the anatomi-al condition of the parts, but also as to the functions of he ear.

It has been advised to remove the whole of such polypi y means of cauterization, especially with Vienna paste in he stick, or with chloride of zinc. I confess I do not onsider the use of fluid caustics, whose effects we cannot imit, as appropriate for the interior of the ear, since injury nay thus easily occur, and an unnecessary amount of pain s caused. *Meniere*[1] states that he has often observed that ecrosis of the osseous meatus has occcurred when, in auterizing aural polypi, the surrounding parts have not een sufficiently protected from the action of the caustics.

I should still remark, that roundish polypoid growths re sometimes removed spontaneously, especially after the ar has been syringed. Very slight hemorrhage then occurs. *Schwartze*[2] has lately described a case where, according to he statement of the patient, a larger polypus fell off of tself. (I am glad to state, that the experience of several hysicians in New York, who see a great deal of diseases f the ear, seems to show that aural polypi are becoming uite rare. This fact must depend upon the improved reatment of the original affection which causes them to ccur. St. J. R.)

Foreign Bodies in the Ear.

More importance has been attached to this part of aural urgery than really belongs to it. Children sometimes lace glass beads, cherry pits, peas, buttons, and the like,

[1] Gazette méd. de Paris, 1857, No. 50.

[2] Archiv für Ohrenheilkunde, Bd. 11, s. 9.

in the ear. Besides, insects sometimes creep into the ear of an adult, and disturb the patient very much.

The presence of these bodies in the ear is generally less injurious than the attempts to remove them. We may take for a motto in this part of our subject, the old proverb, "Blind zeal only does harm" (Blinder Eifer schadet nur).

We may accept it as a fact, that many bodies, especially those that are rounded off and have no sharp edges, as long as they have not been forcibly pressed into the ear, will fall out of themselves, or at least do no harm. The literature of the subject also shows that quite large foreign bodies—e. g., a molar tooth—have remained for years in the ear without doing any harm. Suppurative processes in the ear are indifferently regarded, or considered as a sort of *noli me tangere*, while a harmless bit of bread or paper, a grain of shot, or a pea, is followed up with unrelenting fury, as if its presence placed the life of the patient in immediate danger.

Really we can but wonder how often energetic attempts at extraction are undertaken by physicians as well as laymen before the trouble is taken to ascertain if the patient be in the right, and a foreign body is actually in the auditory canal. There are some caustic descriptions of such attempts, and their consequences, in Wilde's Aural Surgery.[1] There have also been a large number of cases observed in ancient as well as modern times, where patients have died, not, as the histories generally read, from the presence of the foreign bodies, but from the attempts at extraction. In other cases great impairment of the general condition, not to speak of deafness, has resulted.

I was once hurried out of bed by a servant girl, who, with a woful countenance, and tears in her eyes, told me

[1] Practical Observations on Aural Surgery. London, 1853, p. 178.

that an "Ohrenhöllerer," the popular name in Franconia for earwig (*Forficula auricularis*), had crept into the ear, and that some persons had introduced a blade of straw in order to remove it. "Luckily" there lived a young surgeon in the house, who was also called, and by means of a pair of forceps took part in the hunt. He assured her that the animal was removed, but as she had been attacked during the night with severe pain in the ear, she thought the insect must be still there. I illuminated the ear by means of a concave mirror and study lamp, and found certainly no insect, but a very much reddened auditory canal, and intensely injected membrana tympani, naturally the consequence of the hunt which had taken place in the ear.

A more serious case was the following: The lover of a young girl in the country, in sport one evening, placed in her ear a small piece of bread, which could not be removed. A surgeon, who was called in the night, attempted to remove the foreign body by means of a probe, forceps, and scissors, and he also injected the ear with cold water. These attempts to get possession of the piece of bread, renewed several times, were at last obliged to be given up, because considerable bleeding from the ear resulted, and the patient, who had borne up well till then, declared that she could endure the pain no longer. To remove the inflammation, cold water was applied to the ear for several hours. Some days after, I first saw the patient, and found a very severe and extensive inflammation of the auditory canal, it being very much swollen. In spite of energetic antiphlogistic treatment, the inflammation did not subside, several subcutaneous abscesses appeared in the depth of the auditory canal, and the local and general symptoms became so threatening, that I was for some days very anxious for the life of the patient.

The inflammation gradually, however, abated, and in about four weeks she was able to leave her room. I con-

fess this was a little too much for a piece of bread. I would leave such a foreign body to itself, for I cannot see how its presence could do harm, and it would probably during the night or following day get out of itself.

If an insect or other animal creeps into the ear, the simplest and best thing to do, is, to fill the ear with water. The animal being thus inconvenienced, will creep out of itself or be drowned and fall out. If a cigar happens to be at hand, a little tobacco smoke may be blown into the ear. A great surgeon of our day, *Malgaigne*, recommends catching an animal which has crept into the ear, with a camel's-hair pencil dipped in glue, and *Verdue* advises that it be baited with a piece of golden apple. *Hyrtl* well remarks that such propositions are too ludicrous to be considered by the surgeon. We can scarcely believe, however, what ridiculous and laughable expedients have been suggested for the removal of foreign bodies from the ear. Thus, the well known *Itard* recommends that seeds be left in the ear till they have sprouted, and that they then be removed by the sprouts. *Bermond* (1834), reported that he had removed a bean by placing a leech upon it. *Rau*,[1] from whom I take the last example, considers the proceeding as calling to mind the method of *Arculanus* (1493), who recommended that the head of a recently killed lizard be placed in the ear. Three hours after the insect would be found in the mouth of the lizard.

A great number of forceps, nooses, perforators, etc., have been recommended for the removal of foreign bodies from the ear. Some of them are of very complicated construction, and their number does not diminish even at this day. It is true, that there is considerable room between the figure of a hook and the oval or ellipsoidal contour of the auditory canal, so that a small lever can be introduced under the offending body. In such cases, however, a properly

[1] "Taschenbuch der Ohrenheilkunde." Berlin, 1858, p. 376.

injected fluid will also collect behind the body, and wash it out, or dislodge it so that the removal can be completed with the angular forceps, or so that a thin and broad body can be introduced behind it, such as is found on the handle of a Daviel's spoon.

If, however, there is no room between the walls of the auditory canal and the foreign body, we shall only incur the danger with any one of these instruments, of lacerating the wall of the passage or of sinking the body still deeper, and of pressing it against the drum of the ear, whereby the condition of things will be made considerably worse. In some cases, a space may be made through which water may pass, by the use of a lever placed behind the foreign body.

In the great majority of cases, injections of luke-warm water, properly made, to which a little soap may be added in order to lubricate the parts, will do more to remove such foreign bodies, than all direct attempts at their extraction. If the latter are attempted, the parts should be well illuminated, and perfect quiet of the patient be assured. During the syringing, the head should be so inclined as to favor the exit of the foreign body, and the auditory canal be straightened by traction on the auricle. Generally, a lateral position with the ear directed downwards, will be the best, but when the foreign body is firmly held in the depression, which the lower wall of the canal makes close to the drum, a recumbent position, with the head hanging over backwards, will most favor the exit of the body. When there is swelling of the integument about the body, I would apply a leech or two on the meatus.

If a case came under my observation, where an impacted body produced such symptoms, that an energetic treatment for its removal was indicated, and delay as above recommended was not practicable, I would remove it by making an opening through the wall of the auditory canal, and

seizing the body from behind. Paul of Ægina (1533), and the other ancient surgeons recommended in such circumstances, in cases of necessity, to immediately make a crescent-shaped incision behind the ear; and, *Hyrtl* calls particular attention to this method, which has been abandoned by *Malgaigne*, *Rau*, and others. I agree fully with the principle involved in this operation, although, I would not enter from behind, but from above, choosing another position for the incision, for various reasons.

The posterior auricular artery runs immediately behind the auricle in the angle which it makes with the mastoid process; this artery is quite a large vessel, and this is the point indicated for an incision. In incising here, one could hardly avoid doing injury to the vessel. Furthermore, we would be prevented from separating the concha and the cartilaginous portion of the auditory canal, on account of the curvature or arching of the mastoid process, and we should not be able, therefore, with a curved instrument to go deeply enough. I have, however, satisfied myself on the dead body, that we can easily separate the auditory canal from the squamous portion of the temporal bone, and thus with a curved aneurism needle, reach the plane of the membrana tympani. This operation is doubly easy in children, where there is scarcely any bony canal, and where by the sinking in of the temporal bone, out of

the most pressing necessity. Once more, never forget to assure yourselves that the story of the patient is true; see if perhaps the auditory canal is not already free, and if the symptoms are not merely those resulting from previous attempts at extraction.

Furthermore, do not attach more importance to foreign bodies in the ear than really belongs to them, and first attempt to remove them by the simple injection of water, with or without a preceding anti-phlogistic treatment. Our aged fellow-countryman, the accomplished city physician in Nuremburg, says: "Chirurgus menti prius et oculo agat, quam manu armata," in German, "Der Arzt muss zuerst überlegen und untersuchen, bevor er operirt." The surgeon should consider a case very carefully with mind and eye, before he resolves upon an operation.

(I once removed a button from the ear of a child, which had been forced through the drum, in the attempts to remove it, by the continuous application of poultices, which brought the foreign body to the meatus. St. J. R.)

In one case, where a little brass ball of three and a half mm. in diameter had passed through the membrana tympani into the cavity of the tympanum, and I had unsuccessfully attempted to force it into the auditory canal by driving in air and water through the catheter, I at last hit upon the idea of snaring it with Wilde's polypus forceps. In this way I removed the body, which was in plain sight, without any pain. I would suggest the use of the same instrument in similar cases.

If we have seen that more importance is sometimes ascribed to foreign bodies in the ear than is their due, I would now like to call your attention to a class of cases which demand a very careful regard. I would ask you to look to the ear for the explanation of some cases of disturbances of the system, which do not seem to originate in the ear since the effects of irritation of the auditory canal, especially

examined, because pain was never complained of in this part. *Wilde* relates a case of epilepsy and deafness which, according to the view of the observer, arose from the presence of a foreign body in the ear, and was relieved by its removal. It is well known that epilepsy and other nervous diseases may occur as reflex symptoms, from the pathological irritation of peripheral nerves, as well as from the irritation of the nerve center itself.

When we consider these facts, and how abundantly the ear is supplied with sensory branches from the trigeminus and pneumo-gastric, in connection with the above experience, we should not always assign other causes for extraordinary symptoms, until we ascertain if there be not a possibility of their arising from the ear. In the course of our observations we have often spoken of constitutional disturbances which are more or less distinctly connected with aural affections, and hence I do not consider myself presumptuous when I hope there is a day coming when, in a considerable number of diseases, intelligent surgeons will consider the ear, as well as the pupil, as a part to be always examined.

(In addition to the very interesting remarks of the author on this subject, I would like to add, that I have seen four cases of monomania on the subject of foreign bodies in the ear. While surgeon at the Eye and Ear Infirmary of this city, two cases presented themselves to me where the patients, both of whom were females, imagined that there was a pin in the auditory canal. No amount of reasoning could convince these patients that no pin was there. My friend, Dr. C. E. Hackley, suggested that a pin be placed in the water, which was done, and, after syringing for some time, we attempted to convince one of the patients that this pin was the one complained of. She was satisfied for a few moments, but soon found that there was another there. In a third case, the

LECTURE XXVIII.

NERVOUS DEAFNESS.

Anatomy of the internal ear; nervous deafness; want of exact anatomical and clinical proofs of its existence; a case of sudden deafness occurring in an artillerist; disease of the semi-circular canals, with cerebral symptoms (Meniere); *secondary affections of the labyrinth very common; Helmholtz's theory, and partial paralysis of the organs of Corti; deafness in intra-cranial disease* (*aneurism of the basilar artery, epidemic cerebro-spinal meningitis;*) *diagnosis; general remarks on the relative infrequency of primary affections of the labyrinth.*

GENTLEMEN: We now turn to the most deeply situated part of the ear, the so-called internal ear, and its diseases. I must refer you to the hand-books of descriptive and microscopic anatomy, for the finer details of the structure of this part. We, in our anatomical studies, have only a practical object in view. We must, therefore, be content with general descriptions. We are less justified in going into detail, from the fact that new investigations are making considerable changes and amplifications in our knowledge of the anatomy of the internal ear.

Apart from the auditory nerve—the sensory nerve of the auditory apparatus—we divide the internal ear into two

The auditory nerve is divided into two chief branches. The anterior or cochlear nerve passes to the cochlea and its vestibular attachment, the round saccule; the posterior or vestibular nerve, proceeds to the elliptical saccule and the ampulla of the semi-circular canals. No nerves ramify on the membranous semi-circular canals, except those on their dilated or enlarged beginnings, or the ampullæ.

Towards the *meatus auditorius internus* the two labyrinth cavities, the vestibule and cochlea, have a number of cribriform perforated places in their walls (called *maculæ cribrosæ* in the vestibule, and *tractus spiralis foæmniosus* in the cochlea). Through these perforations the tuft-like radiations of the auditory nerve pass to the different parts.

The internal auditory canal, in which the facial nerve runs along with the auditory, must be considered as a lateral canal of the skull, since it is covered by a continuation of the meninges, and is filled by the cerebro-spinal fluid.

Hyrtl states that he has found fluid which he had injected into the sub-arachnoid space of monkeys in the vestibule. He did not make the experiments on the human subject. "It is not impossible that the perilymph of the vestibule is cerebro-spinal fluid."

Nervous deafness.—A Distinguished opthalmologist once described amaurosis, or nervous blindness, as that affection of the eye in which the patient sees nothing, and the physician also nothing. Since the discovery of the opthalmoscope this definition has lost its point, for with its aid we can recognize many different changes in structure in cases of amaurosis. Yet, we may avail ourselves of it for nervous deafness, since this is that disease of the ear in which the patient does not hear, and the physician does not see.

We must decide that a patient is affected with nervous

deafness when we can find no change in the material structure of the auditory apparatus, from which the diminution or loss of the power of hearing can be deduced. Of course such a diagnosis requires a very exact knowledge of the parts, and a thorough capability of observing slight deviations from the normal; and nowhere is the degree of advancement of the physician, and the stage of development of science, better shown than in the diagnosis of nervous diseases.

With every increase of our knowledge of the morbid processes taking place this side of the labyrinth, and with every improvement of our method of examination, the field of nervous affections of the ear becomes smaller.

On the other hand the diagnosis "nervous deafness" will be the oftener made, the less the surgeon is able to distinguish the different affections, the less he understands how to examine the affected portions, and the less knowledge he has of the pathological changes of the external and internal ear.

Examinations of other fields of science, as well as the history of medicine, teach us, that in proportion to the improvement of the objective modes of examination of nervous complaints, and the progress of science, and the influence of pathological anatomy, the diagnosis "*nervous*" becomes, to a certain degree, a chance hit, a declaration of

Let us confess, gentlemen, that we are apt to call those affections "nervous," which we can neither diagnosticate nor improve by treatment.

How much reflex influence the degree of advancement of the physician has in the frequent acceptation of the term—nervous deafness—may be seen, perhaps, by noticing the different phases of development in the writings of one of the oldest aural surgeons of the present day, *Wilhelm Kramer*. This author says, that while formerly he considered nervous affections to be the most common of all of the ear, almost exceeding fifty per cent of all the cases, now, with the advance in pathological anatomy, especially in the study of exudations, he has reduced their frequency to a minimum—four in a thousand.[1]

Let us see, now, what may be said from the stand-point of anatomical and clinical facts, in relation to nervous deafness. Its anatomical substratum must necessarily be sought for in the labyrinth—in the auditory nerve and its source of origin, and finally in the brain, whose disturbances of circulation will always declare themselves in the internal ear; since the vessel carrying blood to the labyrinth is a cerebral artery, and the veins, *venæ auditoriæ internæ*, enter into the venous sinuses of the dura mater.

Rudolph Wagner says: "One of the most humiliating tests of the incompleteness of our knowledge of the functions of the parts of the brain is this—that the central organ of hearing is entirely unknown, while we certainly know that for sight. I think it probable that it is to be sought for in the medulla oblongata spinalis.[2]

Very few morbid changes have as yet been observed in the labyrinth, which fact is due to the unexplored condition of this branch of science; and we are not certain if

[1] See New Sydenham Translation of Ohrenheilkunde der Gegenwart. "Aural Surgery of the Present Day." Berlin, 1861, s. 39.

[2] Zeitschrift für ration. Medezin. 1861, B. 10, s. 277.

the processes which have taken place in the middle ear are primary, and those of the internal ear only secondary. And, furthermore, some of the so-called changes may be normal conditions; such as the greater or less quantities of otoliths, and the presence of the often spoken of black pigment, which, in almost every healthy ear, may be found in different parts of the covering of the labyrinth.[1] Many alterations may depend on post mortem appearances, which show themselves very quickly in these parts, and make the decision as to the signification of the appearance difficult.

Toynbee,[2] who has made the greater number of sections of ears, gives, as among the appearances of the labyrinth, the following: extravasations, exostoses, thickening and atrophy of the integuments, insufficiency of the semicircular canals, hypertrophy of the cochlearis muscle. However, his descriptions are extremely short and fragmentary, and he does not appear to attach much importance to "nervous deafness" in his text-book.

Voltolini speaks much more of the diseases of the internal ear. In almost every temporal bone of deaf persons which he examined, he found morbid changes in these parts, and therefore he, like *Kramer*—except that his opinions are based on anatomical grounds—considered nervous deafness the most common of the diseases of the ear.[3]

that the greater number of ear patients suffer from "nervous deafness."

Up to this time, none of these anatomical conditions have been observed on subjects whose cases were studied during life; so that clinical confirmation of the alleged frequency of nervous deafness is wanting. We are as yet chiefly limited to those cases where the probabilities are in favor of the nervous or cerebral nature of the affection, but where, again, the pathological evidence is wanting.

According to *Arth. Bottcher*,[1] concretions of phosphate of lime, occur on the covering of the *porus acusticus internus*, most frequently on its base, and in old persons. We may then believe that the hearing becomes affected, at least when the collection is very great, and when it seizes upon the neurilemma. The peculiar structure or formation, occurring in the membranous semi-circular canals should be also mentioned. It has been observed by *Lucae*, *Politzer*, *and Voltolini*, and in healthy ears. We can not, as yet, give any definite idea as to its nature or importance to the organ of hearing.[2]

Thus it is often said by patients, that after somewhat large doses of quinine, they have suddenly been attacked by a violent singing in the ear, accompanied by considerable difficulty in hearing, an affection, which generally—although not always—entirely disappeared after a while. These phenomena appear generally, accompanied by other symptoms of poisoning or narcotization. They must, therefore, no doubt, be attributed to the effect of quinine upon the brain, or upon the vascular system. In this connection, also belongs that temporary deafness, which *Von Scanzoni* several times observed, after the application of of leeches to the vagina, usually connected with a general vascular excitement, and with the eruption of *Urticaria* over the whole body. Hysterical and chlorotic patients often

[1] Virchow's Archiv, 1857, xii, s. 104.

[2] L. C., xxv. B.

experience peculiar vacillations in the power of hearing, which together with the negative appearances in the ear are in such singular sympathy with the general health, and the sexual functions, that they can only be denominated "nervous" phenomena. As in fainting, a transient singing in the ear, together with difficulty in hearing, appears, so also is it the case with the longer existing anæmia of the brain, after a great loss of blood, or after some debilitating diseases. To this may be added, in part at least, that impairment of hearing, with negative objective symptoms, which is observable in people suffering from typhoid fever, a difficulty which generally disappears of itself in convalescence, with the improvement of the general health, or under an invigorating treatment.

On the other hand, hyperæmia of the structures of the labyrinth, with serous infiltration or ecchymosis may occur in continued fever, just as in acute purulent catarrh of the cavity of the tympanum.

As is well known, severe concussions, or a fall on the head not unfrequently excite "nervous" deafness. Of the former class, I am able to relate to you, among other instances, a very striking one from my own experience. In the summer of 1858, an artillerist, Martin Baumann,[1] from Ansbach, 21 years old, was brought to me by the military surgeons Drs. Rast and Hausner. He himself, a strong, and as yet, always healthy man, states that he received in his ninth year, a blow on the ear from his father, in consequence of which he heard nothing in that ear for eight days. Whether he had any suffering with it, or on which ear he received the boxing, he cannot say. But he asserts quite confidently that he was able to hear perfectly well after that, until within two days. He states, that two days before, during artillery drill, he was connected with the service of a six-pounder gun; and that he stood during the firing about two feet from the muzzle, his face parallel with the caliber of the gun. The first six shots, which followed each other at intervals

[1] I have given the patient's name for the benefit of any surgeon under whose observation he may come.

of about ten minutes, excited a strong and unpleasant sensation of concussion. At the seventh shot, he felt an extremely violent pain in both ears, "as if a javelin was stuck through his head." From this moment he was deaf. This violent pain lasted about two hours. After that he experienced only a violent singing noise, together with a dead feeling in his head. The patient, who spoke extremely loud, understood only when spoken to slowly and distinctly through an ear-trumpet; he did not hear a loud ticking clock, on the mastoid process, but only on the frontal bone; and then he stated that he did not *hear*, he only *felt* a gentle concussion.

In his organ of hearing, there seemed to be nothing out of order, excepting a slightly elongated red spot in the back half of the right membrana tympani, behind the middle of the malleus. This spot, which was a slight linear rupture, or small extravasation, rapidly grew paler, and continually smaller, and after two weeks it was scarcely discernible. Air blown in by a catheter entered easily and clearly from both sides, without any further phenomenon. With the exception of a dull feeling in the head, the patient was perfectly well. He had a good appetite, and all his functions were normal. His treatment in the military hospital consisted at first of calomel and jalap in aperient doses, simultaneously with cuppings on the neck; afterwards, inunction of *tartarized antimony* ointment behind the ears. The condition remained steadily the same, except that the patient gradually talked less boisterously. Twelve days after the accident, I commenced a treatment by faradization of the ears, first with a quite weak and brief current, slowly increasing its strength and the duration of the sittings. The negative pole was held in the entrance to the ear, which was filled with water, the positive pole rested on the moistened *mastoid process*, and afterwards on the neck also. After the treatment the tinnitus was a little stronger for a time. A violent pain in the ear accompanied stronger currents, and there was also some injection of the malleus. This electric treatment was continued daily for six weeks, with slight interruptions, without any change of the condition. The patient felt well before and after, except the continued dead feeling in the head. Malingering, which must be guarded against among soldiers, was not to be thought of, judging from his whole conduct. Moreover, during the whole time of his treatment, he was continually watched in the military hospital; and also, after he had been dismissed at his home, where he followed his trade as a glove-maker.

A report was made at the year's end, that his deafness continued unchanged, although it became soon less apparent, as the very intelligent patient quickly accustomed himself to observing the motions of the mouths of speakers.

I believe, that this case can scarcely be explained in any other way, than by the supposition that the violent explosive concussion, in this, perhaps, peculiarly predisposed person, produced a paralysis of the acoustic expansion, either directly (as sometimes the destruction of the optic functions is reported by a sudden excessive dazzling), or indirectly in consequence of hæmorrhage in the labyrinth.

If deafness occur after a fall on the head, it may often connect itself with changes in the brain, or with a fracture of the base of the skull, which, as you know, exends frequently through the temporal bone. For instance, there lives here a whitewasher, an extremely jovial fellow, who many years ago fell from a church steeple, which he was about to whitewash. He lay for a time in the Julius Hospital, in consequence of a fracture of the skull; and since this accident, is so stone-deaf, that he assured me, that for the sake of trial, he had placed himself near a cannon being discharged, and that he had certainly *felt* a concussion in his head and feet, but that he had *heard* nothing of the report. Such cases of absolute want of appreciation of sound are extremely rare, for even deaf and dumb people frequently appreciate a loud noise, for instance, the report of a percussion cap, or the ringing of a bell near the head.

One of the most valuable contributions to the science of nervous deafness, we owe to late French investigators, especially to the late Dr. *P. Menière*, of the Paris Deaf and Dumb Institute, who was altogether one of the most meritorious workers in the province of aural surgery.

Menière, in the year 1861, drew attention to a series of most remarkable cases, which appeared in the form of an apoplectic congestion of the brain, with sudden vertigo, vomiting, great singing in the ears, and a fainting condition, and which frequently left behind a certain impediment in motion, a continuing unsteadiness in standing and walking, and thus gave the surgeon from the beginning an impression of a congestive affection of the brain; but the constant recurrence of all these disturbances, and the fact that there generally was a very remarkable difficulty in hearing, for which no assignable change in the ear could be found, decidedly proved that there was an affection of the internal part of the organ.

As if it were known to him that only a short period remained to him, in which to make known his observations, *Menèire* published them in rapid succession, in the *Gazette Médicale de Paris*, in 1861.

The affection of the hearing proved itself to Menière, despite all local and general methods of treatment, to be incurable; while the constitutional disturbances, which appeared so threatening, disappeared gradually, and the patients afterwards enjoyed complete health. Menière, as a warrant for the presentation of this new form of disease, communicates a considerable series of histories of patients, and condenses his experiences in the following propositions:

1. A hitherto entirely sound organ of hearing may suddenly become the seat of functional disturbance, which consists in a humming in the ears of very varied nature, now continuous, again intermittent, to which is soon united a decline in facility of hearing of various degrees.

2. These functional disturbances have their seat in the inner part of the auricular apparatus, and have the power of exciting apparent cerebral attacks, such as vertigo,

stupefaction, unsteady motion, whirling motion, and sudden falling down. They are also accompanied by inclination to vomit, actual vomiting, and by a sort of fainting condition.

3. These attacks, which occur after complete intermissions, are always followed by a greater or less degree of difficulty of hearing, and more frequently the power of hearing becomes suddenly completely annihilated.

4. It is most probable that the material change which lies at the foundation of these disturbances has its seat in the semi-circular canals.

This conjectural view that the seat of the disease was the semi-circular canals, Menière supported partly by a similar case, on which a post mortem was had, partly by certain physiological experiments. The first is a case of a young girl, who in a night journey on the imperial of a diligence during her menstrual period, caught a severe cold, became suddenly completely deaf, experienced at the same time a continuous vertigo, vomited at each attempt to move, and on the fifth day died of the disease. The brain and spinal cord were entirely sound, and the ear showed no pathological change whatever, except in the semi-circular canals, which were filled with a red, plastic lymph, a sort of bloody exudation, of which scarcely any traces showed itself in the vestibule, and none in the cochlea. The physiological experiments, which must be here mentioned, are those of *Flourens*, who, as is known, after the removal of the semi-circular canal, in doves and rabbits, noticed different kinds of staggering movements, unsteadiness in walking and standing, with evident loss of equilibrium, and frequent tumbling down.

An experiment of *Signol* and *Vulpian*, recently laid before the society of Biology, is of great importance to this topic. (*Brown Séquard*[1] considered the observation of

[1] Gazette Hebdomadaire, 1861, No. 4, p. 56.

Flourens as the result of the stretching of the auditory nerve occurring in the experiment, since he saw the lateral rolling movements when the acoustic nerve of animals was traumatically irritated. However, *Flourens* could produce no disturbances in motion by destroying the expansion of the nerve in the cochlea and vestibule, although the auditory nerve must have been then more stretched than in opening the semi-circular canals.)

Signol and Vulpian observed a rooster, who, after a combat with his antagonist, presented precisely the same disturbances of equilibrium, and other manifestations in movement and rest, with those Flourens noticed after the injury of the semi-circular canals, and similar to those which Menière reported in the above named cases. At the post mortem section every abnormity of the brain and its integument was wanting; on the contrary, there was a partial necrosis of the temporal bones, by which a greater part of the inner and middle ear of one side, as also the semi-circular canals, were for the most part destroyed. This case seems to speak, to a certain degree, for the correctness of *Flourens'* discovery, and serves, at all events, as authority for the assertion that diseases of the inner part of the ear are calculated to call forth identically the same results as the direct experimental injuries of this organ.

Politzer[1] has recently reported an extremely instructive case. In consequence of a fall on the back of the head a fissured fracture occurred, which was continued on both sides through the petrous portion of the temporal bone. The immediate consequence, apart from a loss of consciousness of some hours, was complete deafness, with severe tinnitus, vertigo, and an uncertain, staggering gait. In the seventh week after the fall, acute suppurative basilar meningitis occurred, which, as the post mortem showed,

[1] Archiv für Ohrenheilkunde, II, 2, s. 88.

was caused by an extravasation from the left vestibule, which degenerated into pus. Hemorrhage into the vestibule in consequence of a fracture of the temporal bone, thus produced the symptoms detailed by *Menière*.

These communications are extremely worthy of notice, and should incite us to exact observations and experiments in this direction. The subject, nevertheless, may in no manner be considered as concluded. Manifold demonstrative dissections, and various corroborations of the facts are necessary before this may be said to be true. I myself remember, in my somewhat extensive practice, only a few cases which were analogous to that of Menière, although here also certain symptoms were not to be rejected, which implied a catarrhal process in the tympanum.

In addition, we must remember, as has been already said, that all the symptoms detailed as pathognomonic may arise from various diseases of the ear—especially from the stoppage of the meatus by ear-wax or other material; from acute and sub-acute catarrh, and purulent processes in the cavity of the tympanum. We have seen that when these conditions cause vertigo and heaviness of the head, we must consider them as symptoms of abnormal pressure, made upon the drum, and therewith upon the *ossicula*, or upon the last articulation of the latter, the stapes, and its fenestra.

As we have seen, this pressure may be caused by a collection in the auditory canal, or in the cavity of the tympanum, or by a permanent closure of the tube, and by the one-sided pressure thus exerted upon the membrana tympani.

The increase of pressure, which was produced in a peripheral manner, and transferred from the stapes to the vestibulum, must necessarily place the semi-circular canals in an abnormal state of pathological irritation, and this condition might be designated as the same with

all these different forms of disease of the ear which are followed by vertigo; and perhaps it is of importance only for the extent of the appearances, and their further results, whether the irritation is one transferred from the periphery, or one that arises mainly in this division of the labyrinth itself. In any event we must, for the present, be on our guard not to infer from similar instances that there is a primary affection of the semi-circular canals, or of the nervous apparatus. We should be extremely cautious in the diagnosis, if a little time before the sudden diminution in the hearing power there were some symptoms of an aural affection, and also in cases that do not come under observation until some time after the apoplectiform deafness. Catarrhal processes of the tympanum sometimes localize themselves upon the wall of the labyrinth and the two fenestræ, and a high degree of deafness appears with manifest symptoms of irritation of the inner part of the ear; while, on the other hand, the changes on the tympanum are little manifested, and the remaining inferences which result from the condition of the mucous membrane of the throat, and the use of the catheter, frequently exist only in the beginning of the affection.

I fully agree with *Politzer*, when he, in the course of an excellent analysis of the above described case, says: "Sometimes we are able to exclude any affection of the cavity of the tympanum, and diagnosticate one of the labyrinth. These are cases where the classes of symptoms detailed by *Menière*, appear without previous ones, where they are very severe, and when the surgeon is able to examine the ear shortly after the attack. If, for instance, a person who has formerly heard well, becomes suddenly deaf, or hard of hearing, with the symptoms of an apoplectic attack, and there is at the same time an uncertain and staggering gait, but there are no symptoms of paralysis in other nerve tracts, and if the examination shows a

normal membrana tympani, and perfectly permeable Eustachian tube, we may believe with great probability that there is an affection of the labyrinth.

An affection of the cavity of the tympanum which suddenly appears, with great impairment of hearing, and the above described very marked symptoms, is characterized by a speedy and abundant plastic or muco-purulent exudation. Perceptible changes on the membrana tympani, and in the permeability of the tube, will then exist. Some time after the attack the diagnosis will be very difficult, since the products of the affection in the cavity of the tympanum, may disappear without leaving any anomaly on the drum or in the tube, and the very great impairment of function may be caused by an anchylosis of the *ossicula auditus.*"

That diseases of the middle ear often show themselves in a secondary manner on the labyrinth, we noticed before where we found that in every case of catarrh of the Eustachian tube—in consequence of one-sided atmospheric pressure, which weighed upon the membrana tympani—that the stapes is pushed further inward, and thus the fluid of the labyrinth is exposed to an increased pressure, which condition, if somewhat longer continued, will leave behind it lasting disturbances in the nutritive supply of the ear.

Besides, we may believe, in all probability, that in a case of deafness of long standing, as, for example, from complete immobility of the ossicula, or calcification of the fenestra rotunda, that an atrophy of the acoustic expansion, with retrogressive metamorphosis of the fatty or colloid degeneration may occur as a consequence of the deficient specific excitation of the nerve.

Deafness to certain tones.—This may be the proper place to mention a class of anomalies of audition which,

up to this time, because resisting all explanation, have been considered merely as curious facts. There are people who, although they have an extremely acute and good hearing power, have never in all their lives heard the chirping of a cricket. This is said to be the highest tone that we know.

It more frequently occurs, that suddenly, after some kind of an impression, most frequently after a violent concussion of the ear, from a shrill whistle, or an explosion near the ear, that either a whole class of tones, the highest or lowest, are not perceived, or that certain tones become false, that is, they are heard a third or an octave too high.

Helmholtz believes that the acoustic expansion in the vestibule, and in the ampullæ, serves for the perception of the non-periodical or irregular vibrations, that is, for ordinary sounds, but that *Corti's* fibers in the cochlea are designed for the perception of the periodical movements of the air, that is, for the musical tones. According to *Helmholtz*, the tuning (Stimmung) of the latter is different, and corresponds to the regular gradation of the musical scale. The perception of different hights of tone is therefore a perception or sensation in different nerve filaments. In this view, the different quality of the auditory sensations or perceptions as to hight of tone and sound color (Klang farbe), must be referred to the variety of the nerve fibers which is excited.[1]

This extremely ingenious theory may sufficiently explain the above mentioned clinical observations.

For a very masterly analytical observation of a case of "partial paralysis of the organs of *Corti*, we may thank *A. Magnus*.[2] This author, at the same time, hit upon the ingenious idea of using a hearing tube in which several of *Helmholtz's* resonators were inserted,

[1] Die Lehre von hen Tonempfindungen, Braunschweig, 1863, s. 219.

[2] A. F. O., II, s. 268.

in the relief of the affection. These were to be those adapted for the missing tones.

In a case of deafness for bass notes, for example, we may believe that the fibers of *Corti*, set in vibration by the deep tones, can not perform their functions. The false sound of certain tones may be referred to the alteration in certain fibers, by swelling or partial pressure, and so on.

Deafness from intra-cranial disease.—In discussing those forms of nervous deafness that are produced by certain intra-cranial processes, it becomes our task to speak of all pathological conditions that may exert pressure upon the auditory nerve during its course, or which may cause any change at its origin and in the fourth ventricle. It is well known to you, from cases in the medical wards, that the hearing is not infrequently very much affected in apoplexy, cerebral tumors, inflammation of the brain and its meninges, and in hydro-cephalus internus, and that the symptom of deafness often aids us in diagnosis.

I may only briefly allude to aneurism of the basilar artery as a not infrequent cause of deafness, and of severe tinnitus aurium. The English authors, *Gull* and *Ogle*, and recently *Greenfield*, have particularly called our attention to the fact that an aneurism of this variety not infre-

intellectual functions—and finally paraplegia or general weakness of all four extremities.[1]

A constant sensation of knocking in the back part of the head should not be lightly considered.

Deafness from cerebro-spinal meningitis.—I must also allude to the relative frequency of aural affections in epidemic cerebro-spinal meningitis. One of the most common complaints of the patient in the beginning of this affection, is, of noise and singing in the ears. At the same time pain in the ear and aural hallucinations occur, and very often more or less impairment of hearing, which may become complete deafness. These symptoms do not so often appear in the latter course of the disease as in the beginning. The patient usually becomes deaf in both ears. The deafness frequently remains as an incurable residuum of the disease, and seldom disappears.

Numerous pathological changes, according to the reports of post mortem examinations, which have, however, not been very numerous, seem to indicate that the disturbances of hearing occurring in cerebro-spinal meningitis, very often depend upon morbid processes in the fourth ventricle.

We can hardly accept the view of *Hirsch*[2] and *Ziemssen*, that pressure of the product of inflammation upon the nerve after it has left the medulla oblongata, is more frequently the cause of the deafness, since on the one hand the acoustic nerve has not unfrequently been found buried in pus, without there being a trace of deafness during the course of the disease, and, on the other, paralysis of the facial nerve has been very rarely observed, as accompanying this form of deafness.

Inflammation and collections of pus in the cavity of the

[1] Archiv für Heilkunde, 1862, 6, s. 61.

[2] Vide *Hirsch* on "Meningitis cerebro-spinalis," Berlin, 1866, which I have freely used.

tympanum have been found in several cases. We may possibly imagine that this has resulted from the careless use of cold applications to the head. Is it not possible that the pus formed at the base of the brain, following the auditory nerve and its cuff-like expansion, may enter the labyrinth?

A. Eulenberg found the vestibule and cochlea in a state of purulent inflammation in two cases. The question occurs whether this internal suppurative otitis occurred independently and at the same time with the inflammation of the membranes of the brain and the spinal cord, or whether it is to be regarded as consecutive, as a continuation of the meningitis following the course of the neurilemma. *Eulenberg* takes the latter view, judging from the appearance of the nerve, which he found in both cases saturated with pus. It is to be regretted that the labyrinth has, up to this time, been so rarely carefully examined in cases of cerebral spasm.

Treatment. — Inasmuch as marked improvement sometimes occurs in this variety of deafness, we should never neglect in the beginning to exhibit the so-called resorbents among which remedies good nourishment certainly ranks high. Injections of iodide of potassium through the meatus may be of value in recent cases. In old cases, such as usually come to the aural surgeon, I have

individual cases, in considering the impairment of hearing as dependent upon morbid changes in the parts of the ear beyond the cavity of the tympanum? It is only in rare cases that the history of the patient will aid us to form any definite conclusions. The objective appearances in a pure affection of the labyrinth or cerebrum, are negative, since the membrana tympani and Eustachian tube will be found in a normal condition. The appearances are also negative, however, in those cases of great impairment of hearing, which are chiefly or exclusively dependent upon morbid processes in the cavity of the tympanum, that have become localized on the two fenestræ.

In the case of diseases of the eye, we have visual tests that enable us to form definite conclusions as to whether there is any disease of the optic nerve and retina existing in conjunction with the turbidity of the dioptic media.

The physiology of the sense of hearing has, unhappily, thus far, not taught us what degree of deafness may arise from simple peripheric causes, and from what point we must necessarily suppose that there is an affection of the nervous apparatus. Even if we can connect certain higher grades of deafness, on general hypothetical grounds, with a lack of perceptive organs, still every intimation of a settled boundary line is wanting, in front of which, peripherical interference with the conducting of sound alone is possible, and behind which, only dullness of the brain or the acoustic nerve and its expansion is imaginable. It is certain, and established experience proves, that primary morbid processes in the cavities of the tympanum produce a high degree of deafness, perhaps with an inclusion of the influence which they exercise through the fenestra in a mechanical way upon the contents of the inner part of the ear. Let us consider, by way of illustration, a case where the stapes is immovable, and surrounded by masses of bone; consequently the fenestra ovalis is quite shut, and

the membrana tympani secundaria is converted into a thick, inelastic or chalky plate, and the entire canal of the fenestra is filled with a compact plug of connective tissue; nevertheless, the labyrinth may still be normal, but the acoustic fibers can be reached only by those vibrations which are transmitted to them through the denser parts, namely, the skull bones.[1]

The diagnosis becomes very difficult if there are distinct catarrhal conditions, either in the membrana tympani or Eustachian tube, and a question arises as to whether the impairment of hearing, etc., depend solely on the peripheral affection, or if there is still a deeper seated one which may be considered as a secondary process.

We often find in persons whose hearing is impaired, and who have [illegible] suffered from constitutional syphilis and especially in children with syphilitic parents, that there is an impairment in hearing [illegible] through the bones which is not in perfect accord with the [illegible] of hearing conversation. Perhaps there is here a [illegible] affection of the labyrinth.

This question as to whether the labyrinth has been affected, is in certain cases of great practical importance with relation to the prognosis.

We have already seen how much testing the conduction of sound through the bone, especially by the tuning fork,

clusions which the pathological anatomy of these parts has as yet furnished us, some general observations as to the relative frequency of peripheric and nervous affections of the ear may be allowable. In the eye, as is well known, diseases of the retina and optic nerve are much less frequent than affections of the tunics and dioptic media. Yet the conditions in the eye are more favorable for the development of disturbances of nutrition in the nervous apparatus than is the case in the ear. The retina and the entrance of the optic nerve are in an elastic sphere which is exposed to external influences and accidents, as well as to a change of pressure from within. The retina is also connected to the brain, as well as to the choroid and vitreous humor. The internal ear is independent, both as to its nutrition and osseous capsule, of the other parts of the ear. Its artery, the *auditiva interna*, does not come from without, like the vessels of the external and middle ear—from the carotid, but from the cerebrum, arising from the subclavian artery. It springs either immediately from the basilar, or from the inferior cerebellar artery. According to the examinations which have as yet been made, there does not always seem to be a constant connection between the vessels of the middle and external ear. Thus, secondary disturbances of nutrition of the labyrinth, proceeding from the vascular current, can only be produced by congestion and hyperæmia within the skull, and not from the same conditions in the peripheral divisions of the ear. The labyrinth is also formed much earlier than the petrous bone. Its ossification is entirely independent of that of the surroundings.

Hyrtl[1] says that the isolated injection of single vessels is alone able to furnish conclusions as to certain conditions, and states that the question as to the complete independence of the vessels of the auditory labyrinth from all

[1] Handbuch der Zergliedeungs Kunst, s. 652.

its neighbors is only to be determined in this way. *Henle*[1] also says: "All these vessels of the labyrinth form an independent vascular territory. When the *art auditiva* and *meningea media* are injected with different materials, the labyrinth alone is of the color of the auditiva; the remainder of the temporal bone is of the color of the meningea media.

We are obliged, therefore, in view of what is as yet known, to believe that the seat of the affection of the ear is much less frequently found in the labyrinth than in the sound-conducting structures and spaces. Of course this view is only valuable in the want of a better—*salva meliora*, as the lawyers say—and until pathological anatomy shall show us a greater frequency of primary changes in the internal ear.

Under the title of "acute inflammation of the membranous labyrinth, generally considered to be meningitis,"[2] Voltolini describes an acute disease having severe cerebral symptoms, fever, vomiting, etc., in which the patients who are chiefly children, become quickly deaf, and usually perfectly so, and after which a staggering gait remains for a long time. According to Voltolini, there is no doubt that the labyrinth is destroyed in this disease; "a diagnosis may be made from the symptoms merely." He even goes further and says: "I would almost deny the existence of cerebro spinal meningitis, and consider it as an acute inflammation of the labyrinth." Apart from this latter statement, which reminds us of *Erhard*, Voltolini's certainty in the diagnosis is unintelligible, since he himself confesses that he has not yet had an opportunity of proving the existence of this new form of disease on the cadaver. It is possible, that in the class of cases in question, which are unfortunately not rare, that we have an inflammation of the labyrinth. We may at least assume this as probable. Whoever does more is acting in an unproper and unscientific way.

[1] Handbuch, B. IV, s. 123.

[2] Butler & Brinton's Half-Yearly Compendium, part I, p. 74. Monatsschrift für Ohrenheilkunde, No. 1.

Where a doubt exists whether we have to do with a catarrhal or nervous difficulty in hearing, whether with disease of the middle or the inner part of the ear, you will do well, in my opinion, in every relation, scientific as well as humane, to consider the first form as the more probable one; especially since in this event a proper treatment, in most instances, at least, is able to stop the progress of the affection, while real changes in the inner part of the ear, if not dependent upon anomalies of blood and circulation, are, as a matter of course, almost entirely removed from our therapeutic interference.

I have tried strychnine, through the catheter, endermatically, and in sub-cutaneous injections, as well as electricity, without, however, being able to see any especial results.

LECTURE XXIX.

NOISES IN THE EAR, OR TINNITUS AURIUM.

OTALGIA.

GENTLEMEN: We may to-day, devote ourselves to the study of those states of irritation of the auditory nerve which are known by various names, such as noises in the ear, buzzing in the ear, and which we in general terms may designate as subjective sounds—subjective aural sensations. The causes of these sensations in the ear, which do not depend upon an irritation of the organ from external sounds, may lie in the various parts of the ear, and depend upon the most difficult affections, just as we have met with tinnitus aurium as one of the symptoms of most of the affections of the ear that we have as yet studied together.

Each irritation of the acoustic nerve, from any direction, will declare itself by sensations peculiar to this nerve.

The subjective sounds in the ear must always be regarded as an expression of an irritation of the auditory nerve, whether of its trunk or its terminal expansion in the labyrinth. In this view, however, we do not include those cases where real sounds exist in the interior of the ear, or in its immediate vicinity, the so-called internal sounds (Binnen geräusche).

You see, that the subjective auditory sensations are closely connected to nervous deafness, since both depend upon a morbid condition of the nervous apparatus. They

differ, however, from each other in the following respect: the former exhibits itself by an increased functional power, although a perverted one; the latter by a diminution. Of course the two conditions may coexist, and this is very frequently the case.

The descriptions of the various sounds which the patients hear in their ears, are exceedingly various. They are usually dependent, to some degree, upon the occupation, habits of thought, etc., since patients usually describe them as like the sounds that they are in the habit of hearing in their daily life.

Some of the comparisons made are very original. A young peasant thought the tinnitus in his ear, was like the sound of a marmot (German mole) whistling in his ear. Another patient described the noise as like "an abominable growling noise, as if a night-watchman sat in his ear, and was grumbling through his hour." (This has reference to the practice which the watchmen have in some old German towns, of singing a song at the beginning of each hour of the night. St. J. R.) In the summer of 1866, during the war, patients in Würzburg, who suffered from tinnitus aurium, complained of the noise of drums, the rattling of ammunition wagons, etc. We thus had an opportunity of seeing the influence of imagination, and the effect of events, daily occurrences upon the subjective auditory sensations.

I once saw a deaf composer who had in other respects a normal mental nature, who informed me that he continually heard a certain hymn in his ear the same one that had made his name famous.

A shorter or longer *after sound* of certain monotonous vibratory impressions, to which a person has been exposed for some time, is very frequent, e. g., after a journey in the railway cars, or after remaining near a large waterfall, and so on.

Continuous, and rhythmically interrupted sounds should be distinguished from each other. Some patients speak of several kinds of tinnitus as existing at one time, so that as they assert, one may be diminished under the treatment, while the other remains unchanged. Some-

times the patients are not able to fix upon one ear as the situation of the affection, but are very undecided about the matter, or say that the noise is less in the ear than in the head, or in the back of the head.

One patient only—she was from North Germany—spoke of a pleasant sort of tinnitus. "The tones were so remarkable—like the most charming notes of a bird—that I often recall with regret this one pleasant feature of my disease."

(By a strange coincidence I have just seen and recorded the case of a lady suffering from disease of the ear, who described the tinnitus as an exceedingly pleasant sound. St. J. R.)

Generally, however, the noise is very unpleasant, even painful. Many patients assert that their deafness is the lesser trouble, and entreat the surgeon to free them from this affection, at whatever cost, because it does not allow them a quiet moment, and prevents them from working, thinking, and even from sleeping. There are cases where such a tinnitus aurium has caused the subject to commit suicide.

(I know of one such case, and I have been informed of another. St. J. R.)

This condition of irritation of the auditory nerve may be caused by various morbid processes. We find subjective sounds in all abnormally excited conditions of the brain, either proceeding from this organ itself, or reflected upon it. In this view we do not include actual cerebral disease. This is the case after any sort of poisoning or intoxication, especially after the use of quinine; in some anomalous conditions of the blood (anæmia and chlorosis); in temporary as well as permanent hindrances to the circulation; (in some cases of cardiac valvular insufficiency, just as in fainting); and in connection with a class of indefinable morbid symptoms, to which the vague,

but as yet not to be banished names, relaxation of the nerves, over irritation of the nerves, nervousness, etc., have been given.

Tinnitus aurium much more frequently depends upon abnormal conditions which may be found in the ear itself. We always find it in acute inflammation of the membrana tympani, and of the cavity of the tympanum, and in all the conditions that increase the pressure upon the fluid of the labyrinth, whether the membrana tympani be pressed inward by cerumen, or the tube be closed, and thus the drum, with the ossicula, lie farther inward. The stapes and its surrounding membrane, or the membrane of the fenestra ovalis, may be directly forced more towards the labyrinth by some cause. Every thickening or rigidity of the membranes of the fenestræ, therefore, if connected with great tension, may of itself produce very disturbing tinnitus. Chronic catarrh is the most common cause of impairment of hearing, and tinnitus aurium seems to most frequently result from it in one way or another.

A shortening of the tendon of the tensor tympani muscle, may be a very frequent cause of a tinnitus, that is only momentarily improved by the use of the air bath. Politzer first called attention to this, and we have already spoken of it.

Every increase of the intra-auricular pressure, of course, causes an abnormal irritation of the nervous expansion of the acoustic nerve in the fluid of the labyrinth. It is possible that it may also cause disturbances in the circulation and nutrition, such as occur in the globe of the eye when its walls and its contents have been for a long time subject to abnormal conditions of pressure.[1]

Very severe tubal catarrh often occurs, however, with distinct pressing inward of the membrana tympani, without tinnitus aurium. Cases have also been examined *post*

[1] Wiener mediz Wochenschrift, 1865, Nos. 67-72.

mortem where, according to the appearances of the stapes, there must necessarily have been considerable pressure upon the contents of the labyrinth, and yet the patient has never suffered from tinnitus, except at the inflammatory beginning of the disease. We may accept the view of *Schwartze*, that the contents of the labyrinth may be gradually accustomed to a certain increase in pressure without the occurrence of these subjective auditory sensations.[1] Besides, we may remember that any interference with the base of the stapes will differently affect the ear, according as the membrane of the fenestra rotunda is normally elastic or thickened. This may explain the fact that tinnitus aurium usually increases with the age of the patient. I have also observed severe tinnitus in very young children, but this symptom is comparatively less frequent and troublesome than in adults.

Chronic hyperæmia of the ear will also produce this troublesome symptom. We not unfrequently, however, meet with very great vascular development on the membrana tympani, when the patient does not complain in the slightest of tinnitus.

Aural catarrh without perforation of the membrana tympani, is much more frequently connected with tinnitus than the same disease where an opening exists. This is explained by the fact that the discharge of the secretion as well as the equalization of the outer and inner pressure of air, are rendered easier by the opening.

Although affections of the peripheral parts of the ear, because of themselves occurring more frequently, most frequently produce conditions of irritation in the labyrinth, the fact should not be overlooked that these latter may be caused by diseases within the labyrinth itself. The disease of the semi-circular canals described by *Me-*

[1] Archiv für Ohrenheilkunde, I, s. 212.

nière, of which we have already spoken, is always accompanied by severe tinnitus aurium.

Politzer found on the cadaver of two patients who had died of typhus, small ecchymoses in the vestibule, with catarrhal changes in the middle ear. *Schwartze* found great hyperæmia of the cochlea in one case of typhus. It is conceivable that subjective sounds, such as occur in typhus, may depend on such morbid processes in the labyrinth.

We have already observed that deafness and tinnitus occur from great concussions. Cases also occur, however, where after severe sounds the acuteness of hearing is not at all affected, but where there is the so-called false hearing in connection with ringing or singing in the ear In such cases we may believe that the terminal expansion of the auditory nerve, in consequence of the great concussion, is brought out of its position of equilibrium, and is thus placed in a temporary or permanent condition of irritation. (*Politzer.*) Thus, I saw a young man, a short time ago, who, on the day before, had suffered from the explosion of a small toy pistol close to his left ear. Since then he had heard everything, even his own voice, in a less distinct tone than normal, and he had a continuous ringing in his ear. He could hear a watch from six to seven feet on that side, while he heard on the other ten feet. The tuning fork was heard more plainly towards the right when placed on the center of the teeth. The tone of the watch was not as clear as normal from the left temple, while that of the tuning fork was not so distinct when from the left ear. The objective appearances were negative, apart from naso-pharyngeal catarrh. Air passes readily in through the catheter. Sounds are somewhat clearer in the left ear. *Hourteloup's* artificial leech was applied to the left mastoid process. The day after his condition was the same. In a few days, under a purely expectant treatment, the ringing

in the ear and dullness of hearing was gone; last of all he got rid of the want of clearness in the sound of his own whistling. He finally heard the tuning fork with equal distinctness in both ears. It is more frequently the case, however, that the acuteness of hearing is considerably altered after such sonorous impressions.

Cases also occur of severe tinnitus aurium, in which the hearing is normal or ample, that is, very little lessened. Hyperæmic processes in the naso-pharyngeal space have a great deal to do in causing such affections, extending, as they may, for some distance into the tube.

Fleischmann relates an interesting case of *tinnitus aurium*, arising from a foreign body in the Eustachian tube. A man complained for years of a continuous sound in the ear, and of a very peculiar sensation in the pharynx, as if a hair had got into his mouth. On the post mortem section, a grain of barley was found projecting from the pharyngeal orifice of the tube, and reaching from there into the osseous tube. Such a case could now be diagnosticated by means of the rhinoscope, and possibly relieved.

Every severe cold in the head is usually accompanied by a temporary tinnitus aurium. Quite often every other symptom disappears except the tinnitus. Gradually diminution of the acuteness of hearing also occurs. To the hyperæmia are then added the actual pathological changes. It is more rare, after an acute inflammation of the ear, that the hearing again becomes normal, while continuous tinnitus remains. Such conditions, which may perhaps be referred to limited vascular anomalies, small aneurisms or varicose formations in the cavity of the tympanum, or in the labyrinth, are often very obstinate to local treatment, even though it be continued for years.

Tinnitus aurium is an evidence of an irritated condition of the auditory nerve. In consonance with this the

[1] Linke's Sammlung, II, s. 183.

condition of the whole nervous system, the general condition, and especially the social and psychological condition of the patient will always have an influence upon it.

Heurnius[1] says: "*Tinnitus aurium plerumque a flatibus originem habet,*" and now a days, our Franconian peasantry have an idea that wind from the stomach which has got into the ear, is the cause of the tinnitus.

Even a very slight tinnitus becomes very troublesome when a patient is very much depressed, tired, or suffering from any bodily ailment. On the other hand, a regular life, good society and pleasant feelings have the contrary effect. The external influences that increase the tinnitus—sudden change of weather, very damp, or very dry and hot weather, and a very warm room—in chronic catarrh of the middle ear, are especially to be mentioned. Full meals, and especially the use of alcoholic stimulants, with very long continued bodily exercise, usually increase the tinnitus. On the whole the patients feel better in the open air than in a close room.

Turck, of Vienna, first drew attention to the fact that a temporary effect could be produced upon tinnitus aurium by pressure of the finger upon the mastoid process. It is usually lessened by this pressure. *Politzer* confirms this view after numerous experiments.

Benedict, has recently ascribed an extended importance to the reflex irritation of the auditory nerve, from the track of the tri-facial, based upon electric examinations. I have long observed the striking fact that some patients complain of an increase in the tinnitus, whenever they place the finger on certain parts of their face, the eyelids, temples or cheeks, or when they shave.

I have already said, in speaking of chronic catarrh, that the existence of a continuous noise in the ear is an un-

[1] De morbus oculorum, aurium, etc., 1602.

favorable prognostic sign. Other things being equal, in all affections of the ear, the prognosis is always more favorable when there is either no tinnitus or subjective sounds in the ear, or when they only occur at intervals. It is an extremely interesting fact, on the other hand, that sometimes tinnitus aurium occurs, or that which already exists during the treatment of chronic catarrh, is increased at the same time that the hearing is markedly improved, and the formerly deficient perception of tones from the bones is gradually increased. This state of things is not very frequent, however, and may only be explained by supposing that the sensitiveness of the acoustic expansion, which was previously diminished for all kinds of air impressions, is now increased, both for normal and morbid irritations. It much more frequently occurs, however, that the tinnitus and impairment of hearing increase and decrease *pari passu*, in equal proportion.

Apart from these purely subjective sounds, which are to be considered as symptoms of an abnormal irritation exerted upon the auditory nerve and its expansion, certain acoustic sensations, which are caused by actual tone-exciting vibrations, are comprehended under the name of tinnitus aurium. These vibrations are not caused without the body, but are actually produced within it, and are called *entotic* sounds.

Thus the internal sounds described by the patients as "striking," or "pulsating," are for the most part nothing more than vascular sounds having an arterial origin, whether arising from the internal carotid itself, which passes through the temporal bone in a sinuous course, or in the small arteries in and around the temporal bone. We may voluntarily produce temporary but very decided arterial sounds in the ear, by certain sudden rotary movements of the head, especially when lying in bed.

In cases where the contents of the venous sinus, which surrounds the carotid artery during its course through the bone, is changed into a coagulated rigid mass, every hindrance to the conduction of the pulsation of the artery is removed, and this is probably perceived by a pulsating sound in the ear. The same thing occurs when there is an aneurism of the artery, or when the osseous canal is narrowed at a certain point, so that a portion of the carotid comes in direct contact with the bone.

Certain blowing and hissing sounds heard by chlorotic and anæmic patients, may also be referred to vascular sounds transferred to the petrous bone. I may recall to your attention the fact, that the internal jugular vein, that is, its bulb, quite often lies close under the floor of the cavity of the tympanum. Besides, as you all know, a portion of the wall of the transverse sinus is formed by the posterior portion of the temporal bone. All such sounds, occurring either in or on the ear, must act all the more powerfully on the auditory nerve, when the natural exit of sounds from the ear is hindered in any way, e. g., by thickening or abnormal tension of the membrana tympani.

We may, therefore, believe that tinnitus aurium, much oftener than we have thought, has no connection with morbid irritation of the auditory nerve, but depends upon simple entotic sounds, which, although existing for a long time, have been first brought to perception by pathological changes in the sound-conducting apparatus. When so many patients speak of very different sorts of sounds, which increase or decrease under various influences, it may be that the two forms (perhaps we may designate the one variety as nervous tinnitus aurium, the other as material or acoustic) exist at the same time.

It has already been mentioned that a knocking sound is often heard in the back part of the head, when an aneu-

rism of the basilar artery exists. *Rayer*[1] reports a case of pulsating tinnitus, isochronous with the beat of the heart, which was perceived by others than the patient, on auscultation, and which was momentarily checked by compression of the mastoid branch of the posterior auricular artery. There was no real aneurismal enlargement of the vessels, nor valvular insufficiency of the heart, or morbid tone in the aorta or carotid, so that the sounds seemed to originate in some peculiarity of the branches of the posterior auricular artery, or in some change of the parts. *Rayer* takes the opportunity to recommend the practice of auscultation in cases of tinnitus aurium, in order to distinguish if the morbid sounds are perceived by the patient only, or if they may also be detected by the physician. *Politzer* also saw an old man who complained of continuous rough blowing sound in the ears, which was isochronous with the pulse, in whom a strong systolic murmur was perceived on auscultation, not only over the heart, but also on the ear and head.

Just as in many rodentia and gnawing animals, insects and bats, the internal carotid passes through the side of the stapes, so in man, according to Hyrtl,[2] there is always a capillary arterial branch between the sides of the stapes, through to the promontory, and, exceptionally, there is a larger artery running through the stapes. When the last-named state of things exists, it seems to me scarcely questionable that pulsating internal noises in the ear depend on this communicated motion of the stapes, to which the patient may accustom himself, so as not to observe them, just as the miller does not observe the noise of his mill.

The well known crackling sound, belongs among the internal sounds of the ear that may be objectively recog-

[1] Comptes rendres des Séances et Mémoires de la Sociéte de Biologie. Année, 1854, p. 169.

[2] Vergleichend-anatom. Untersuchungen über das innere Gehörorgan des Menschen und der Saügethiere. Prag: 1854. S. 40.

nized, that is, may be perceived by others. Many persons are able to produce this sound voluntarily. It was formerly considered as depending upon voluntary contraction of the tensor tympani, but according to Politzer[1] it results from the sudden drawing away of the membranous portion of the Eustachian tube, which occurs during contraction of the tensor palati. *Luschka* expressed the same opinion at the same time. *Lowenberg*[2] also furnished further proofs that the tube opened when this crackling sound was made.

Very many persons hear such a delicate crackling sound at every act of swallowing—especially when the mucous membrane is somewhat affected by catarrh—which may easily be mistaken for a sound in the ear.

Boeck[3] has recently demonstrated, by a rhinoscopic examination, that the tube opened in such a case. In a case which *Schwartze*[4] described as chronic spasm of the tensor tympani muscle, a visible contraction of the membrana tympani was seen at every crackle, together with elevation of the uvula. Certain temporary sounds that occur in the ear when catarrh exists, and which probably depend upon the bursting of a mucous bubble, or the like, should also be mentioned, as well as a peculiar rattling or flapping sound that some patients with impaired hearing complain of, as occurring in one or both ears when the head is shaken.

Treatment.—I do not know any special treatment for tinnitus aurium. We must treat the disease which causes it. The subjective sensations in the ear comprehended under the term tinnitus aurium, most frequently depend upon the abnormal pressure which pathological changes on

1 Wiener Medicinal Halle, 1862, No. 18.

2 Mediz Central Blatt, 1865, No. 32.

3 Archiv für Ohrenheilkunde, II, s. 203.

4 L. C., II, s. 4.

the fenestræ of the labyrinth, and an increased projection inward of the stapes, cause to be exerted upon the fluid of the labyrinth. These changes on the fenestræ, and the altered position of the stapes, may depend upon disease situated either in front of, or behind the membrana tympani. This explains the fact that frequent air baths, the introduction of warm vapors, or medicated fluids injected through the catheter, often diminish the tinnitus, and the sense of pressure in the head that usually accompanies it, even in cases where scarcely any improvement to the hearing results from the treatment.

(My experience shows, that I have oftener succeeded in improving the hearing than in lessening the tinnitus dependent upon chronic aural catarrh, although the sensations of fullness in the head, and vertigo, are usually relieved. St. J. R.)

The treatment of chronic catarrh and of tinnitus aurium are usually one and the same. Diluted glycerine has very often done good service, either injected through the catheter, or dropped into the external auditory canal. Some persons immediately perceive a diminution of the tinnitus on pouring warm water into the ear. It is often necessary to tell the patient not to press a wad of cotton into the meatus. This is a very common kind of malpractice in Germany, which of itself alone may cause tinnitus.

I have used all sorts of narcotics as additions to vapors and injections through the tubes, as instillations into the auditory canal, and rubbed behind the ear, and generally with not even a temporary benefit. I would most advise you to try an injection of cloroform mixed with olive oil or glycerine. Sometimes subcutaneous injections of morphine diminish severe tinnitus for a time. A vesicant also, sometimes, is of avail when a constant tinnitus is temporarily increased in severity. Rarefaction of the air in the auditory canal by means of an india-rubber tube,

hermetically inserted into the meatus, generally lessens the subjective sounds, although usually for a short time only. In very desperate cases we may perforate the membrana tympani. Unfortunately the opening soon closes up.

Tinnitus aurium in the insane.—It is a very important question, whether the aural hallucinations occurring in insane patients, do not frequently depend on peripheric tinnitus, which is exaggerated by the patients. It would be well worth the trouble, if physicians for the insane would examine the ears of such patients. I am indebted to my esteemed friend Prof. *Ludew Mayer*, formerly director of the Insane Asylum, in Hamburg, for the history of a melancholic patient, who was relieved of a sound in the ear, seeming to the patient to be the cry of a child, by the removal of a plug of inspissated cerumen, which caused deafness of one side. The patient from that time on made a rapid and complete recovery.

Very recently, *Schwartze*, an aural surgeon, and *Köppe*, a physician for the insane, have made this question a subject of investigation. They have reached some remarkable results as to the dependence of certain psychological symptoms upon peripheric aural affections. Schwartze says: "Subjective aural sensations, which are caused by demonstrable affections of the ear, may, in predisposed persons, especially when there is any hereditary tendency to mental disease, become the direct cause of aural hallucinations, that may accelerate the outbreak of mental disease. I have treated such a patient for a long time, and she has been protected from a threatened attack by local treatment of the aural disease. *Dr. Köppe*, assistant physician to the Provincial Insane Asylum at Halle, examined this patient with me, and is convinced that the treatment caused the above-mentioned result. In other cases, insane persons, who suffer from aural disease, distinguish its tinnitus from their illusions or hallucinations. They hear their "sounds" simultaneously, but independently of the tinnitus aurium.

Köppe speaks in the same way, more in detail. He examined thirty-one insane persons in the above-named institution, in whom considerable disease of the auditory apparatus could be detected. In none of them, was there tinnitus, without, at the same time, the existence of aural illusions and hallucinations. Seven insane persons also had a chronic hyperæmia of the vessels of the handle of the

malleus, and besides the subjective aural sensations, aural illusions and hallucinations.

In two cases of inspissated cerumen, the tinnitus disappeared after the removal of the plugs of wax, but the hallucinations remained. In several cases, which are fully detailed, both the tinnitus and the hallucinations disappeared after local treatment of the ear. Two cases were particularly interesting, where only one ear was affected, and where the sounds were only heard on that side.[1]

Otalgia.—To these anomalies of the sensation in the ear we may add hyperasthesia of the sensory nerves of the ear. We usually call this nervous pain in the ear *otalgia nervosa*. Pain not depending on inflammation, called neuralgia of the tympanic plexus by *Schwartze*, occurs much more rarely than is usually believed. The error in diagnosis arises from an insufficient examination of the ear.

There is, however, a pure neuralgic pain in the ear, having a typical course, which is an extremely troublesome affection. It most frequently results from caries of the molar teeth. In several such cases that I have observed, the pain disappeared when the carious tooth was removed, and in another it was removed by filling the cavity. In some cases I have used subcutaneous injection of morphine behind the ear.

(*Dr. Weir* has kindly furnished me with the notes of a case where the removal of a carious tooth immediately relieved pain in the ear. St. J. R.)

Pain in the ear seems also to occur as a reflex sensation from the pneumo-gastric. *Gerhardt*[2] has observed severe pain in the ear in ulcerative destruction of the epiglottis, "almost constantly." It may either exist permanently, or only during the act of swallowing.

1 Berliner Klinische Wochenschrift, 1866, Nos. 12, 13, allegem Zeitschr für Pyschiatrie, 1867. Bd. XXIV.

2 Virchow's Archiv, B. XXVII, s. 5.

LECTURE XXX.

DEAF-MUTEISM.

Its nature, and the causes of its origin; medical and educational treatment.

THE APPLICATION OF ELECTRICITY IN DISEASES OF THE EAR.

Faradization of the ear; the constant current.

EAR-TRUMPETS.

GENTLEMEN: The subject of deaf-muteism naturally follows the discussion of nervous diseases of the organs of hearing. A child that is born deaf, or that has become so in the earliest years of its life, never learns to speak. Even children who have learned to talk, again lose this power if they have become deaf at an earlier age, say about the seventh year. Even from the years of eight to nine, conversation may be very indistinct from loss of hearing. Although we usually speak only of a congenital and an acquired form of deaf-muteism, it seems to me practically necessary, and of vital importance, to distinguish three original varieties.

I. Congenital deaf-muteism, comprising cases where the child has never heard, and has never spoken.

II. Early acquired deaf-muteism, where a child actually hears a little, but not well enough to speak as one of his age should.

of hearing, perhaps about that which in an adult would enable him to understand only when the words are pronounced slowly and loudly close to his ear. Such will be the case with adults who formerly heard, and who have been always accustomed to speech, and who are still able to indicate the fact that the words do not sound distinctly to them. In the case of the adult, reading from the mouth of the speaker, and putting together the half heard and broken sentences, will very greatly assist the listener. But how will the same amount of impaired hearing affect a little child? It has not as yet learned to hear, so to speak, or to fix its attention upon speech. The words of the mother are to the infant, the same as those of an unknown tongue to us, when we do not know what the words reaching our outer ear indicate or express.

Such a child, who only distinctly perceives what those around him say, under peculiarly favorable circumstances, that is, only exceptionally, and who, as a consequence, must learn the sense and meaning of words very gradually and slowly, or perhaps not at all, such a child, I say, will soon cease to interest himself in what is said, and will chiefly confine himself to the interpretation of signs and gestures, and will still less endeavor to reproduce words, because that which alone excites the disposition to speak ourselves — the speech of others — does not exist for him.

For the above-named reasons the habit of hearing will be less and less practiced, the child impresses us as being a completely deaf creature, to whom it would be folly to speak. The inducement is wanting, and thus the child will become more and more deaf and dumb, who at first was really only hard of hearing. The same child, however, if we speak to him slowly and distinctly in the ear, just as we do to the adult who is deaf, and if the objects are before his eye which we are talking about, will at all events learn to hear, and even to understand what the words

express. He will take an interest in conversation, and try to imitate what he has heard, and even endeavor to speak himself. He will simply remain hard of hearing, and be able to express himself tolerably well.

We should not leave out of consideration the material changes which appear under the form of regressive metamorphosis, in consequence of the want of a specific irritation in the auditory nerve, and perhaps, in the brain. These, in the very nature of things, must be much more quickly developed in the infantile organism than in a fully grown person.

The condition of things is similar when a child that already speaks becomes very hard of hearing in early life. Even in an adult an imperfect hearing of ones own voice has an unpleasant influence upon the modulation and control of the voice. A child, on the other hand, who does not hear those around him well, nor his own voice, soon loses the power of speaking distinctly, and of speaking at all, unless great strictness is observed in teaching him to speak distinctly, by constantly using—if necessary, by means of a hearing tube or trumpet—the little hearing power that he has. It is also necessary to accustom the child to watch the mouth of the person.

You will now understand how we are able, by means of great personal attention and methodical instruction in speaking and vocalizing, to *cure* certain forms of deaf-muteism, or, more correctly speaking, to prevent high degrees of impairment of hearing, from developing into deaf-muteism. The treatment is very similar to those methods of education which are now carried on in the most approved institutions for deaf-mutes, only that at a later period the vocal organs have lost, to a great extent, their capacity for modulation, and a characteristic, animal-like, howling appears, unless very great care be taken by the teacher, in the vocal education.

B. Meckel, a very capable instructor of the Deaf and Dumb in Camberg (in the former Duchy of Nassau), has done me the favor, at my request, to write me a letter containing some criticisms on the lecture on deaf-muteism, as it appeared in the former editions of this work. He writes, among other things: "It is of course true that deaf-mutes who are brought into an institution for the education of deaf-mutes in their eighth year, or later, are frequently awkward in the use of the organs of speech, especially in that of the tongue. According to my experience, however, I cannot admit that the power of modulation is to any great extent destroyed by the non-use of the organs of speech. Much here certainly depends on the manner in which the instructor seeks to develop sounds from the scholar, and the way in which he causes him to use them. In this institution we practice those just received, for some months in a very exact and correct production of the consonants and their different combinations, long and short, just as they occur in conversation, without adding the vowels. In this manner speech becomes very flexible, and when the vowels are employed, in speaking words, a normal tone of voice is secured by most deaf-mutes. You will only find the animal-like, howling voice, in our institution, in those deaf-mutes incapable of cultivation. In producing a good tone in the speech, the remnant of hearing power which the deaf-mute may have, as well as the intonation of the voice, the length and shortness of the syllables on the part of the teacher, come into consideration."

As a matter of course, medical treatment must be introduced as soon as possible, with the systematic instruction. I could relate to you, from my practice, several cases in which deaf-muteism was obviously prevented, or was checked, or caused to retrograde, when in a condition of development. For instance, there is under my treatment at present, a child four and a half years old, who, from the first months of his existence, has suffered from a profuse discharge from both ears, and is conscious only of loud sounds. Until within a few months, when I saw him for the first time, he was able to produce only an inarticulate barking, and other sounds which were unintelligible even to the mother, so that he was already properly con-

[illegible] mentions intermarriage as a cause of [illegible], with which deaf-muteism is often [illegible]. Scarlet fever should be prominently mentioned as a cause of acquired deaf-muteism, as well as the different forms of meningitis and continued fever.

[illegible] different cases of deaf-mutes in the excellent [illegible] for the education of this unfortunate class in this city, and in Hartford, Connecticut, made by my friend, Dr. G. M. Beard, and myself, seem to confirm the views of the author, that the usual causes of the deafness causing muteism in children, are about the same as those which obtain in cases of deafness occurring in adults. I am inclined to believe that the remote causes which are, moreover, often assumed rather than accurately known, such as "fright of the mother during gestation, intermarriage, etc.," have been studied somewhat too much, to the exclusion of the proximate causes which may be usually ascertained by the ordinary objective examination of the ear by means of the otoscope or ear mirror, and speculum.

The elaborate statistical tables of the causes of deaf-muteism have been usually made up by laymen, who do not realize the fact that [illegible] causes of themselves are of very little value, since they [illegible] as to what pathological changes form the proximate causes. These tables are also made up, to a large extent, of the statements of parents and friends, and thus are very often a mere matter of guess work. The only manner of obtaining a knowledge of the ethology of deaf-muteism is, to first secure a thorough objective examination, and then to add to this the history of the patient, [illegible] the amount of reliance to be placed upon it. Post mortem examinations should of course be obtained, with which to verify the diagnosis.

Of the cases examined by Dr. *Beard* and myself (296 in all) 182, or [illegible] per cent., were probably congenital; 114, or 39 per cent., were probably acquired.

In the so-called congenital cases, all but thirty were found to exhibit changes on the membrana tympani, which indicated local inflammation as the proximate cause of the deafness. It is also interesting to note that very many of the deaf-mutes are much annoyed by tinnitus aurium. This fact also indicates the inflamma-

tory nature of the affection which destroyed the integrity of the organ of hearing.[1] St. J. R.)

The use of Electricity in Aural Disease.

Electricity has been warmly recommended from the time of the last century up to the most recent period, for nervous, and in fact for all varieties of deafness, in the most different methods of application. We should be a little distrustful of any means of treatment that is considered valuable in such a great variety of cases. We should carefully examine into the favorable results which have been reported, to see if an exact diagnosis, or at least a thorough examination of the affected parts has preceded the treatment. We must be doubly careful here, since some other application is generally connected with that of electricity, which of itself might relieve some forms of deafness. I mean by this the frequent filling of the auditory canal with lukewarm water. We know that accumulations of cerumen, dried epidermis, etc., are not unfrequently the cause of impairment of hearing. Such cases are not unfrequently found among those who have been treated by electricity, without any previous examination of the ears.

A person who had been cured of deafness by electricity once, quite honestly, told me that he has been surprised at the amount of fluid ear-wax which was secreted after each application of the agent, so that his handkerchief with which he cleaned the ear was covered by great brown spots.

But apart from such cases, and aside from recent cases of tubal catarrh, or of catarrh of the cavity of the tympanum, where the hearing often varies very much without any treatment, there are related, by creditable authority, many cases where impaired hearing has been improved by

[1] The appearance of the Membrana tympani and Fauces in 296 cases of acquired and congenital Deaf-muteism. American Journal of the Medical Sciences, Vol. LIII, p. 399.

the use of electricity, cases that were of long standing, and which had been examined and treated by various competent aural surgeons.

The use of electricity in diseases of the ear should therefore not be dismissed so contemptuously as it is by some aurists, but we should endeavor, by experiments with the agent, to get an exact knowledge of the proper method of application, and of its effects. There is much to be desired in the resources of treatment in aural disease, and we should endeavor to increase the number of our remedies in all possible directions. An immediate denial of the efficacy of electricity, and a complete rejection of it, in the treatment of the diseases now under consideration, is certainly not a proper way to dispose of the subject. I have often made use of the Faradaic current in treating persons with impaired hearing, but nearly always after a long-continued introduction of vapors into the cavity of the tympanum. Most of the patients affirmed that they heard better after a frequent application of electricity. In the case of others improvement of the hearing was striking, and could be proved as well by conversation as by the watch.

But, in the use of my observations, I exercise the strongest possible self-criticism; for very frequently there must be considerable distrust in these ear cases. Since it is proved that the favorable influence of the vapors appears more after, than during the treatment, I take for the present such assertions and observations of the patients with great care, and I do not yet attempt to prescribe, in any detailed manner, the use of electricity for the treatment of diseases of the ear. One thing, however, seems to me to be quite certain, since its manifestation was too frequently repeated to be merely accidental. Often in the case of those patients whose ears had been Faradized for any length of time, the frequency of the vacillations to which their acuteness of hearing had been subjected, was

decreased, and the deafness and fatigue formerly occasioned by straining to hear, were very much lessened; these phenomena having appeared before in a striking manner, sometimes with, and sometimes without weariness, or a desire for food.

In Faradizing the ear, one conductor, a metallic bar, insulated down to its point, is dipped into the meatus, which is filled with warm water, while the other, in the form of a copper wire which is covered, and bare at the points, is introduced through the catheter some distance into the tube. The parts which the electric current will preeminently influence in this manner, are the membrana tympani, and above all the middle part of the ear, and, in the latter, the interior muscles of the ear, viz., the tensor tympani and the stapedius, as also the muscles of the Eustachian canal. If we were able to perceive the pathological conditions and functional anomalies of these muscles in the living body, it is highly probable that the indications of the applications of electricity in diseases of the ear could be formed more definitely. That muscular diseases also appear in the ear, is not only to be supposed *a priori*, but we have an anatomical proof of it in the case of the muscles of the cavities of the tympanum, since I frequently found them diseased in my dissections of the ear, having undergone cartilaginous, fatty, and granular changes. What place must be assigned to the internal muscles of the ear for the physiological and pathological state of the sense of hearing, has by no means been exactly and definitely determined. At any rate, it will be no insignificant and unimportant one. Heretofore these muscles have been considered a kind of accommodating apparatus. I would like to remind you that a series of morbid phenomena in the eye which, heretofore, have been considered nervous and indefinable, now appear as lesions of accommodation, *i. e.*, anomalies of the muscles of

accommodation. It is conceivable that a similar condition obtains in the ear. The above-cited investigations concerning the influence of electricity may perhaps be explained in this manner.

Duchesne and *Erdmann* speak, in the application of electricity to the ear, of "Faradization of the chorda tympani," against which idea it may be said that this nerve, of all others which here come under consideration, seems to have, at any rate, the very smallest importance to the ear and its functions.

In the Faridization of the ear, in the manner above described, most patients experience a painful contraction in the half of the tongue corresponding to the point of application, together with a peculiar sensation in the ear, like the sound from cooking, the rustling of a fly, as well as a darting pain in the ear. This does not usually pass to the apex of the tongue, but usually stops short of this. More rarely, even when a stronger current is used, there is a metallic or prickly taste on the tongue. The pain in the ear depends of course on the irritation of the branches of the tri-facial, which supply the auditory canal and the outer surface of the membrana tympani. The sensation on the tongue is produced by the *chorda tympani*, which as is well known soon after its passage through the Glaserian fissure, unites with the lingual branch of the fifth. It is peculiar, that the sensation in the tongue does not appear in all persons. On the other hand, patients who have no sensation in the tongue during the application, usually have considerable pain in the ear, even when a very weak current is employed.

I was once able to experimentally observe the influence of the chorda tympani, upon the tongue of the human subject. I had renewed several polypoid excrescences from the auditory canal of a young man, and finally the membrana tympani was plainly seen greatly swollen, and with a fissure like perforation on its posterior and upper portion. As I cleaned the blood and pus away from the membrane with a camel's-hair pencil, the patient suddenly spoke of a decided sensation upon the tip of the tongue of the same side. On examining the part again, I distinctly saw a white point posteriorly and above on the membrana tympani, where it was perforated, which

from its appearance and position, I was obliged to consider as the exposed chorda tympani nerve. I now made a very fine point to the pencil, and when I touched the white spot, the patient immediately spoke of a very decided feeling on the tip of the tongue, which he described as a peculiar pricking sensation, as the "same kind of a shaking that is experienced when the brakes are applied to railroad cars in motion." This sensation was always confined to the tip of the tongue, and the patient, who was very intelligent, said there was no sensation of taste.

Very recently the constant or galvanic current has been employed in aural surgery. *Brenner*,[1] of St. Petersburg, speaks very favorably of its use in the diagnosis and treatment of aural disease, after very extended experience with it. The observations and experiments of *Schwartze*[2] and *B. Schulz*,[3] of Vienna, have, however, led them to a different conclusion. I have no experience of my own on the subject.

Hearing Trumpets.

I may here say something of the mechanical assistances which facilitate intercourse with those whose hearing is very much impaired. These are appliances which cause either the human voice or musical tones to be more easily perceived.

Up to the present time, unfortunately, speculative mechanics have undertaken the construction of apparatuses for assisting the hearing, much more frequently than men educated in physical and physiological science. Hence the science of acoustics has furnished much less assistance to sufferers from aural disease, than that of optics has for those with impaired vision. In other words, gentlemen, spectacles for the ear are yet to be found.

1 Virchow's Archiv, Bd. XVIII and XXXI.

2 Archiv für Ohrenheilkunde, I, s. 44.

3 Wiener Mediz Wochenschrift, Nos. 73, 77.

You will be surprised at the number of hearing trumpets of various kinds which are to be found in the possession of persons with impaired hearing, and very often they are of no service to them. For the most cases a tube of two to three feet long, made of wire covered with stranded leather, with horn extremities, seems to do the best service.

Fig. 40.

Elastic hearing tube.

The ear piece should be well rounded off, so as to fit the auditory canal of the person using it. Under certain conditions, if properly curved, it will stay in the meatus of itself. The funnel-shaped mouth-piece should be held by the person speaking, near his mouth, without covering it, however. It should be small when used for conversation with one person, but large when designed for general conversation, or for considerable distances, when it should be of the size of an ordinary funnel, such as is used in the kitchen.

In listening to lectures or sermons, this end should be laid on the table before the speaker. Such an ear-trumpet can be worn under the collar in the case of men. Similar to this leather ear-trumpet, is one of pasteboard, or of German silver, which, for the sake of convenience, is made in sections, to be joined together when used. Some patients, however, are happy and contented with a cow's horn, simply adapted to the purpose.

I have seen some patients who could not understand a

word with any kind of an ear-trumpet, while they could hear words spoken loudly in the ear when no tube was employed. *Politzer* believes that in such cases the elastic cartilage of the ear contributes in conducting the sonorous waves upon the bones of the head. Since I have often observed that the ear-piece, when made as an oval, slightly hollowed disk, which is held on the auricle, did better service for some patients than the thin extremity ordinarily used for the meatus, I have attempted, in such cases, to employ an ear-piece in which the auricle could still be used to collect the sounds. I can, however, give no accurate results from such experiments.

An apparatus made of gutta-percha, as a rule, deadens tones too much. Those of metal can seldom be permanently worn, on account of their great resonance. This is also the case with all instruments that are worn in the ear continuously. They are usually irritating, and produce permanent tinnitus aurium. Since most persons with impaired hearing are weak enough to wish to conceal their infirmity, they prefer hearing trumpets that are so small as not to be observed, or those which can be placed under the hair. Unfortunately the usefulness of such instruments is generally also invisible.

The ear-clamp, or "Otaphone," said to have been suggested by *Webster*, of London, possesses the advantage of not being seen, and also of being at times useful. It consists essentially of a clamp fastened to the posterior aspect of the auricle, which serves to cause the ear to project further from the head, and it thus causes the reception of sounds coming from the front of the listener to be somewhat easier. As you must have often observed, very many deaf persons have a habit of placing the hands or fingers behind the ear, and thus pressing the auricle forward when they wish to hear a little more distinctly. It is astonishing what an influence upon the hearing this simple ma-

nipulation exerts in some patients. The auricle is often pressed very much against the head, especially among women, by the bonnet or hair, and thus its elevations and depressions are so much flattened out that the functional value of the part is nearly lost. The Otophone is peculiarly adapted for such cases.

(I am very often asked by physicians, as well as laymen, in regard to the value of certain little brass tubes, resembling miniature trachea tubes, designed to be placed in the auditory canal, that have been sold in great numbers in this city. I have never seen a person who has been benefited by their use, even where the walls of the canal have become so collapsed as to very much lessen the caliber of the canal. Such cases of collapse are usually preceded by morbid changes in the inner parts of the ear, which render any increased facility of access of sounds by widening the meatus, of no avail. St. J. R.)

We very often find that patients have a very great disinclination to the use of any kind of a hearing trumpet. Very many are annoyed by such a proof of their infirmity; others less vain and egotistical fear that their hearing may be made worse by the use of any conductor of sound. The latter should not be feared in the use of any properly made instrument. On the contrary, cases are not infrequently met with where partially deaf persons, who have given up hearing with one ear at least, have been able by the use of a listening tube, to acquire such an amount of hearing that they could dispense with the use of the trumpet under some circumstances, when in the beginning they could scarcely hear even by its aid. Not a few patients who have begun to withdraw themselves from ordinary social intercourse, have had a new life given them by the use of an appropriate hearing-trumpet. The fact that a great convenience is thus afforded the friends of the patient, is also a matter of some importance.

LECTURE XXXI.

THE EXAMINATION OF PATIENTS.

Post Mortem Examination of the Ear.

Gentlemen: Before we pass on to a consideration of all the points that are to be considered in the examination of a case of disease of the ear, I would like to impress upon you the necessity of taking careful and complete histories of your cases.

A detailed history of a case, which has been kept during the whole course of treatment, until the discharge, or until an examination is made on the dead body, is the best means of causing a young man to become an accomplished, closely observing physician, as well as one able to give an unprejudiced opinion. Such a purely objective style of examination is also of great value for the subsequent practice of the observer, since it compels him to have a thorough basis for his opinions, and carries in itself the necessity for rigid self-criticism.

The more exactly and objectively does a physician work up the histories of his patients, the greater will be the assistance he can render to science, as well as to suffering humanity. On the other hand, the less he does this, and the quicker he is to make final decisions as to the diagnosis, the earlier and more certainly does he degenerate into a mere mechanic, who follows only the beaten track, or acquires the self-satisfaction which is so convenient and

so common among some old physicians. He thus also attains an unscientific and purely symptomatic idea of the history of a case.

It is hardly necessary to tell you how indispensable are full and exact histories of cases that may run on for years, and how important they become at the post mortem examination. Nowhere is a thorough and purely objective observation of cases more necessary than in the branch of medicine so incomplete as aural surgery, one, we may say openly, which has been very inaccurately studied. Every honest, unprejudiced observer is here a gain for science, because he collects new facts which may serve as the test of those already furnished, and their union renders our knowledge gradually more and more complete. But it is not enough to make a few scanty notes, and at the close to give the preconceived diagnosis, but all the details that the case demands should be furnished, strictly following them out, without any prejudice. All this is best attained by some previously prepared plan or scheme. The one which I employ is the following:

Name; age; occupation; residence; history (duration, earlier and later symptoms, in short, the course of the affection; pain; tinnitus; discharge; it is important to learn if the tinnitus was present before the impairment of hearing, or if it appeared with it, if it increases or decreases with the diminution and impairment of hearing; how long the present condition of the hearing has existed; if it is variable in degree or always the same; probable cause; constitutional disease; present condition; hearing distance for the watch and conversation; conduction of sound through the bones; patient's own voice, is it heard by himself clearly or not; mode of speech; what influences cause the tinnitus and impaired hearing to increase; objective examination; auditory canal; cerumen; membrana tympani (its brilliancy, the light

spot, color, handle of the malleus, curvature, projection in front or behind the short process of the malleus); pharynx; catheterization and air bath (changes in hearing caused by these); general condition; hereditary tendency; diagnosis; treatment.

You see, gentlemen, that so many things are to be observed at the first examination of a patient, that it will consume a great deal of time. You should never allow the patient himself to furnish his case. He is apt to underrate important facts, and overestimate indifferent ones. You should ask the questions, and cause the patient to answer merely, and, even then, you will often be obliged to break up a tedious disquisition, and remind the patient of your question. It is almost incredible how much trouble it sometimes costs to get a direct answer, especially as to the duration of the affection. A patient whose hearing has been impaired for years, will not unfrequently tell you he has been deaf "for about six weeks," after he has excused himself a great many times for being deaf at all, or he will say that he has "only a little noise in his ears," although he is scarcely able to hear the questions asked him. After the patient has stated when his affection began, it is well to ask him if he had perfectly good hearing in both ears before that, and you will often be surprised how far back the real time of the beginning of the disease will be found to be. There are other points where inconsistencies will occur, so that you will not always come to a speedy conclusion as to the condition of things.

(In interesting cases, and where the patient is intelligent, I generally cause the patient to write me his own history of the case. In this way we may often get a thorough account, with less trouble than by the use of one's own pen and voice).

Examination of the Ear on the Dead Subject.

I need not speak to you, gentlemen, of the importance of pathological anatomy, for medical science, any more than I need to tell you that the sun illuminates the earth over which it shines. We have already seen how late it was in the history of aural medicine and surgery before pathological investigation of the ear was undertaken, and that the slow and late development of this part of our science resulted as it necessarily must, from this neglect of the appearances of the organ on the cadaver.

Since the profession in general has an exaggerated idea of the difficulty of making a post mortem examination of the ear, and since if there be not a certain method in opening the organ, the connection of the parts may be easily destroyed, and a view of the actual state of things rendered difficult, I have thought it would be useful to demonstrate to you the proper way of making a section of the organ of hearing.

I must first dissent from the commonly accepted opinion, that a thorough examination of the ear cannot be made without great mutilation of the subject. It is true that we can not make an exact examination without removing the parts from the head, but this may be done in such a manner that scarcely any unpleasant appearance will result.

We attain the desired end in the simplest, quickest, and most thorough manner, if, after removing the calvarium and cerebrum, we make two vertical sections with the saw, one of which passes a little behind the mastoid process, and the other through the lesser wing of the sphenoid bone, and the middle of the zygomatic process. The two may then be run into each other through the base of the skull. If we then exarticulate the lower jaw, and separate the atlas and occiput, we may isolate all the interesting parts by a few vigorous cuts with the knife.

These parts are the petrous bones with the transverse sinuses, the Eustachian tubes, and the pharyngeal mucous membrane, from the fauces to the anterior surface of the spinal column. Since the face, which has been deprived of its support, sinks back towards the occiput, we must fill up the space with straw or a bit of wood. We may avoid all unpleasant mutilation of the subject, in this thorough removal, if we leave the auricle, and only carry one of the incisions, the posterior, through the integument. We may then dissect up the flap, and after the removal of the parts desired, unite the incision below the ear by satures. If the hair of the subject be made available we may so arrange matters that such a cadaver may be examined by even the most distrustful eyes, without the discovery of any defect.

It is not so well, if, from any reason, *e. g.*, the want of a saw that is large enough, we are obliged to remove the temporal bone alone. For this purpose, we cause the above described incisions to converge towards the sphenoid bone, so that this and the basilar portion of the occipital bone are not cut through. We then, by means of a chisel, break through the temporal bone, assisting in the separation with the scissors, which should be introduced as far anteriorly as possible, and below towards the pharynx, in order to retain the most necessary portions of these parts. In this way we only get a view of the naso-pharyngeal space as it is divided, and not in its proper relations, as by the former method.

If we are obliged to avoid all trace of the resection of the skull, we may leave the squamous portion of the temporal bone *in situ*, and separate the petrous portion by means of a chisel and hammer, so that such a section is made of the bony meatus, immediately in front of the membrana tympani, as is seen in Fig. 2, page 22.

After having removed the temporal bone in one way or

another, it will be then best, after taking away all that is superfluous from the preparation, to first remove the anterior wall of the auditory canal, by means of the scissors and bone forceps, in order to get a view of the outer surface of the membrana tympani. After examining the auditory canal and the outer surface of the drum, we turn to the mucous membrane of the pharynx, and the cartilaginous portion of the tube. We should make several sections in order to study the condition of these latter parts. These are made at right angles to the axis of the tube, with a sharp knife. In order to expose the whole extent of the tube, with its muscles, we should remove the zygoma, the anterior portion of the squamous portion of the temporal bone, and the greater wing of the sphenoid, with the bone forceps and saw. For the purpose of more exact examination, it is well to cut off the cartilage of the tube in connection with its lateral attachment to the skull, when the different sections can be kept unchanged. By this method we may best recognize the arrangement of both the muscles of the tube. In order to get a more extended view of the mucous membrane of the tube, in its whole course, we open the membranous portion with the scissors. When the osseous part of the tube has been reached, it is removed piece by piece, and thus we test the condition of its mucous membrane, and the width of the canal. In doing this we keep a little outward towards the squamous portion of the temporal bone, in order to preserve the whole length of the tensor tympani muscle. The nearer we come to the cavity of the tympanum, the slower should we work, and we should always observe the swellings, cord-like, or fold formations near the tympanic orifice of the tube, which frequently pass over to the membrana tympani itself.

I usually leave the uppermost portion of the tube unopened, and first remove the roof of the cavity of

the tympanum, in order to better examine the parts from above. We should then remember that the head of the malleus is found close under the roof of the tympanic cavity, and avoid any contact with it with the bone forceps. We should therefore begin posteriorly to open the *tegmen tympani*, that is, from the mastoid antrum. The point of an ordinary strong pair of forceps may be usually employed to expose the middle ear, after the bone nippers have made an opening.

When we have a sufficient view of the cavity of the tympanum from above, we should test the mobility of the articulation of the malleus and incus, by means of a fine pair of forceps, and observe any adhesions or abnormal connections that may exist. If there are any such, and we wish to obtain a more exact view as to their extent, and so on, without injuring the preparation, it will be best to saw through the anterior portion of the pyramid at a plane which meets the membrana tympani at about a right angle. The anterior portion that has been sawed off on the floor of the cavity, is then broken off, and we may inspect it laterally, and from below, without disturbing the membrana tympani from its position, and the adhesions from their connection with it. (See Fig. 8, page 70.) Such sections of the cavity of the tympanum are in many cases very instructive. Since such a section passes through a portion of the labyrinth, we should first examine this part in a manner to be subsequently mentioned, if, indeed, we find any indication for looking at it at all.

If it be preferred to get a complete view of the inner side of the membrana tympani, and of the wall of the labyrinth, the temporal bone must be divided into two parts—the pyramid on one side, the squamous portion and mastoid process on the other. For this purpose we first cut through the tendon of the tensor tympani, and separate, by means of a delicate little knife, the articulation between

the stapes and incus. After the cells of the mastoid process have been broken into, from behind and above, we turn to the lower surface of the petrous bone, where the transverse sinus, with its transition into the jugular vein, and the internal carotid, with its venous sinus, are more exactly examined. If, now, the lamella between the osseous part of the tube and the carotid canal, be divided by sharp-cutting bone nippers, and then the wall of separation between the latter and the fossa for the bulb of the jugular vein, the preparation usually divides into the two parts desired. We have only to make a few cuts with the scissors through the soft parts of the mucous membrane of the cavity, and the facial nerve.

The outer half of this section shows a part of the cells of the mastoid process, and the inner surface of the membrana tympani, with the malleus, incus, and anterior wall of the bony Eustachian tube. If the incus be carefully separated from its articulation with the head of the malleus, we see the whole extent of the chorda tympani, in its course through the cavity of the tympanum, the insertion of the tensor tympani, and the two pockets or pouches. We may then test the contents of the latter, the existence of adhesions, etc.; we may also examine the condition of the membrana tympani, the degree of its transparency, and finally, if we please, remove it from its attachment. For the purpose of a microscopic examination it is usually enough to cut out a piece.

The other, and inner half of our preparation, consists chiefly of the pyramid, and affords a view of all the parts of the labyrinth wall, as in Fig. 7. Frequently, by the above described opening of the temporal bone, the eminentia pyramidalis is opened so that the stapedius muscle is exposed, and it, as well as the tensor tympani, may be examined microscopically.

We now examine as to the condition of the fenestra

rotunda, its canal and its membrane, and as to the mobility of the stapes, by delicate traction upon the tendon of its muscle, and by a very careful examination of the crura or sides of the bone, which easily break off if the bone be abnormally fixed. We can only get a more thorough view of the membrane of the fenestra rotunda and ovalis, from the vestibule and cochlea. They can only be examined microscopically by opening the labyrinth.

In many cases it will be very interesting for us to know how far the stapes may be movable in its oval fenestra. Pressure upon its head, and seizure of the crus of this little bone by the forceps, may easily give us a false conclusion. Such attempts at an examination should only be made with the greatest care. The enveloping membrane of the base of the stapes may be completely ossified and changed to a thin bony plate, so that the stapes during life could undergo no motion at all, and yet, it appear movable at the first motion with the forceps, because we thus may have broken the delicate bony plate. *Politzer*,[1] therefore, advises that air be alternately blown into and drawn from the auditory canal, before it is removed, through an india-rubber tube. If we have previously opened the vertex of the upper semi-circular canal, and placed a drop of fluid there, upon which a cone of light is thrown, we see, if the stapes be movable, the point of light change its position, on the forcing in the air and withdrawing it from the auditory passage. If this do not occur, a small manometric tube, filled with a solution of carmine, is hermetically introduced into the semi-circular canal. The slightest motion of the stapes will be now perceived by a rising and falling of the fluid in the manometer. If no motion occur, there is no doubt of the immobility of the stapes, provided there be no abnormal hindrances to its motion in the peripheral parts,

[1] Wiener med-Wochenschrift, 1862, s. 2, 14.

which may be very easily determined by opening the auditory canal and cavity of the tympanum, and examining them.

In cases where much depends upon the examination of the internal ear, and the preparation is still recent, it is best to undertake the examination of this part before that of any of the other. If it be an old specimen it should be first placed for some days in a wine-colored solution of chromic acid, or of the chromate of potash. (The latter is to be preferred, on account of the dulling of the instruments which the chromic acid solution causes. I would also call your attention to the fact that otoliths, consisting of carbonate of lime, are dissolved by weak solutions of chromic acid.)

We first examine the auditory nerve by breaking into the internal auditory canal from above, and with it exposing the facial. In the microscopic examination parallel examinations of the facial and other nerves, are much to be advised. If the Fallopian canal be followed from the cavity of the tympanum, and the bending of the facial, we have the most important parts of the labyrinth, the cochlea and vestibule, under this nerve. They may be very readily opened from above, by removing the bony plate in layers, by means of a small chisel.

It is best to examine the cochlea first, as being the most accessible and finer structure. This lies in a median direction from the facial nerve, towards the carotid artery and the tube. When the bony covering has been removed, so that the lamina ossea spinalis are exposed, we should only break off the base of the spiral, which lies towards the meatus auditorius internus, in order to remove the whole modiolus with the spiral layer *en masse*. We will not need any assistance with a dissecting needle or point of the knife on the cupola, which lies close to the tensor tympani, as often as on the periphery of the spiral

turns. If the contents of the cochlea be now placed in serum, or a weak solution of common salt, the membranous spiral turn is brought out, and besides making a general examination with a magnifying glass, we may cut off a part for microscopic examination. Laterally, with relation to the facial nerve, that is, towards the squamous plate, lies the vestibule, with the semi-circular canals proceeding from it. The upper canal is opened on the exposure of the cavity of the tympanum, at any rate when the labyrinth cavity is opened. It takes a great deal of time to chisel off the whole covering of the semi-circular canals, throughout their whole course, as *Voltolini*[1] advises, and as a rule it is not necessary, because we may remove the membranous portion from its bony tubes, and then examine them. We finally test the condition of the fenestra ovalis from within, the transparency of the membranous ring surrounding the base of the stapes, as well as the membrana tympani secondaria. These parts may then be conveniently removed, and a microscopic examination of them be made.

Thus we may examine the different parts of the ear, not only as separated, but also in connection with each other. This method of dissection is also to be advised in the study of the anatomy of the ear. The brain should also be examined in some cases, especially the fourth ventricle from which the auditory nerve springs.

Of course in some cases we are obliged to deviate more or less from the method just given. Where collections of pus exist they should be carefully removed by means of a camel's-hair brush, and by pouring water over them. It is also advisable, after the secretion has thus been removed, to place the preparation in alcohol for a few days, before examining the parts any further, in order to harden them.

The usual instruments for a post mortem examination

[1] Die Zerlegung un Untersuchung des Gehöorganes an der Leiche.

are required for such an examination, with the addition of one or two bone nippers, made like nail nippers. *Luer's* ingenious resection forceps, like a double gouge (*Pince gouge de Luer*) are very excellent. We may work with them very safely, and cut the smallest and hardest portions of bone, at the same time protecting the neighboring parts.

For some fine dissections, as well as in laying open the cavity of the labyrinth, I use a graver's tool and a hand chisel, with variously shaped cutting surfaces. We can work very well with a hammer and small chisel, yet, unless great care be taken, many preparations will be destroyed with them.

The saw should only be used in the preparatory parts of the dissection, since the finest saw will prevent a good view of the parts by the saw-dust, and the twisting and stretching of the soft parts caused by them. The same is true of files and rasps. A vice is often needed to hold the preparation. A board with sides, against which the preparation may be pressed when necessary, will perhaps be sufficient in many cases.

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ERRATA.

Page 33, 10th line from top, for *Glaseri* read *Glaserian.*
Page 56, 4th line from top, for *irruption* read *eruption.*
Page 94, last line, for *aural* read *nasal.*
Page 99, 11th line from the bottom, for *is* read *are.*
Page 124, last line, for *Tourteloupe* read *Hourteloupe.*
Page 188, 3d line from the top, for *of* the Eustachian tube read *to* the, etc.
Page 234, 13th line from top, after *naso-pharyngeal* insert the word *space.*
Page 245, 13th line from top, for *we had like means,* read we had *no* means.
Page 357, in foot note, for No. "17" read "7."
Page 426, 2d paragraph from bottom, for *O.* Erhard read *J.* Erhard.
Page 434, 15th line from bottom, after *of the bone* insert *leading.*
Page 453, 10th line from top, after *canal* omit the comma, and insert *of.*

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INCLUDING THE ANATOMY OF THE ORGAN.

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